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ABSTRACT

Engineering 45 at the University of California at Berkeley is a basic materials course and prerequisite to the specialized courses taken in the 3rd or 4th year of the engineering curriculum. The course objectives are to provide students with an understanding of the relationship between the internal structures and the properties of engineering materials, and to promote students' understanding of how internal structures can be altered to produce desired properties. To help students understand those course materials whose mastery has been consistently problematic, a series of films and slides were devised. To evaluate the effectiveness of these multimedia, audiovisual techniques, the students taking the course were divided into 3 groups: Group I, the control group, was taught in the usual manner; Group II saw the slides and films, but had no special opportunity to review or discuss them; and Group III saw the slides and films, but had also additional learning assignments using audiovisual techniques. The results indicated that the 3 groups did not differ on their total final examination scores, but did differ on their media-related scores. This report discusses these results, and some additional findings of the study, such as the students' feelings about their learning, their attitude toward learning, student characteristics and the predictive validity of the tests in terms of determining what kind of students should be recruited. The exams, the surveys, and the specifications of the film and slide sets are included in the appendix. (AF)

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TOWARD EDUCATIONAL IMPROVEMENT: ENGINEERING 45

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ERIC

CONTENTS

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NOTE

The interpretation of the data and subsequent recommendations that follow are those of the evaluator, and are not necessarily shared by the other members of the project or by the faculty of the College of Engineering.

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INTRODUCTION

The main objectives of the undergraduate engineering curricula at the University of California at Berkeley are to provide students with strong backgrounds in basic sciences and engineering subjects and to promote their ability to adapt to changing needs in the field of engineering. The undergraduate engineering curricula begin with basic courses in mathematics, chemistry, and physics. From these background courses the student advances to basic engineering courses such as Computers and their Applications, Introduction to Design, and Mechanics and Materials. Specialized courses relevant to chosen branches of engineering are taken during the junior and senior years.

Prerequisite to the specialized courses is the basic materials course, Engineering 45, which is usually taken in the sophomore year. The course objectives are to provide students with an understanding of the relationship between the internal structures and the properties of engineering materials, and to promote students' understanding of how internal structures can be altered to produce desired properties.

The importance of the course to the curriculum, together with indication that students were not sufficiently mastering all aspects of the course, led to the introduction of multi-media, audio-visual techniques designed to improve the course. A brief description of these innovations and the evaluation of their effectiveness comprise the primary content of this report of the Engineering 45 Learning Study.

This project was initiated because the course examinations repeatedly revealed that students were experiencing difficulty in grasping certain new concepts. Also, differences in answers to questions on midterms and

on the final examination indicated that improvement in long-term retention of some subject matter was needed, and it was felt that motivation to learn could be improved by the introduction of new teaching methods. More specifically, the objectives of the project were to increase student learning efficiency and motivation.

Topics covered in Engineering 45 include atomic and crystal structure of materials, crystal defects, polycrystalline solids, multiphase materials, microstructures, and the relations between the internal structures of solids and their bulk properties. The materials discussed are metals, ceramics, semiconductors, plastics, cement and concrete, and woods.

The course consists of thirty one-hour lectures and eight three-hour laboratory periods. The teaching responsibility is shared among three departments in the College of Engineering--Electrical, Civil, and Material Science and Engineering--with a different faculty member dealing with each major unit of the course.

The initial problem was not only to determine the areas where teaching-learning improvement was most needed, but also to determine the technique most conducive to improvement in these areas. No single teaching method is best for all students; some students comprehend mathematical or written language better than the audio-visual form of instruction, while the reverse is true for others. Also, the various parts of a single course, such as Engineering 45, must often be presented in different ways. Certain topics, such as those dealing with stresses, diffusion, or electrical properties must be treated mathematically, while others, such as crystal structure and microstructure require visual aids for clarity.

Improvement in motivation can be provided by an inspiring instructor

who has the ability to demonstrate the relevance of the subject matter to the long-term educational objectives of the students. Unfortunately, not all instructors can provide such inspiration, particularly in the traditional lecture situation; therefore, means for providing motivation to enhance student learning must be sought through teaching methods other than the lecture. This can be accomplished in a variety of ways, including the use of well-designed slides, movies, demonstrations, laboratory exercises, student-centered discussion and query groups, field trips, guest lecturers, and personal consultations.

In this context the decision was made by the project staff to devise a series of films and slides to facilitate understanding of those engineering materials whose mastery had consistently been found to be problematic. The decision was also made to provide ample opportunity for some students to discuss these materials and related presentations in situations beyond what would normally result from a teacher-centered lecture. Finally, the decision was that some students should have the opportunity to review the slides as often as they wished outside formal class presentation in an audio-visual laboratory established for this purpose.

DEVELOPMENT OF THE INSTRUCTIONAL MEDIA

Members of the faculty collaborated with the University Extension Media Center in the production of two films and four slide sets for the purposes of the study. The films were on: (1) Crystal Structure and (2) Transistor Fundamentals. The slides were on: (1) Crystal Structure, (2) Transistor Fundamentals, (3) Planar Technology, and (4) Portland Cement. Only two films were used because of the prohibitive developmental costs, a

ERIC

persistent problem in projects of this kind.

Appendix A contains a summary of the specifications of the films and slide sets together with examples of slides from the Crystal Structure and Transistor Fundamentals sets.

PROCEDURES FOR EVALUATION

On the basis of the considered possibility that the instructional media materials would have important relevance to engineering program improvement in the future, a considerable effort was devoted to their development. Consequently, evaluation of the nature and results of the project was essential from the project's inception. Of prime concern was to discern whether introduction of the media to students resulted in desirable learning behavior which did not occur among students who did not have the benefit of this experience.

A traditional, "quasi-experimental" design provided the major basis for the evaluation. A "control" group and two "experimental" groups comprised, respectively, all students taking Engineering 45 during the Fall, Winter, and Spring Quarters of the academic year 1968-1969 (the course is repeated each quarter). The "control" Fall Quarter course purportedly proceeded as it always had. The first "experimental" Winter Quarter course included use of the slides and films, but the students did not have any special opportunity to discuss them or to review them subsequently.

In the Spring, the slides and movies were also used, but additional "learning assignments" were made. These assignments consisted of viewing a series of slides, similar to the new ones used during lectures, but more

complete, which were shown in student operated booths set up in the Engineering Library specifically for this purpose. Supplementary text material was prepared and made available for students to study while viewing the slides, and the students could view the materials as often as they wished. The intention was also that the students in this second experimental group receive special guidelines before observing the materials as well as the opportunity to discuss and clarify them in class afterwards.

The obvious hypothesis was that the second (Spring Quarter) "experimental" group would perform significantly better on measurable criteria compared with the first "experimental" group and the "control" group, and that the latter--which had none of the special instructional materials--would exhibit the poorest performance. Performance criteria included: (1) the course grades; (2) scores on the final examinations; (3) scores on the laboratory problems; and (4) scores on individual items in the final examination specifically related to the media materials. Additional criteria included the students' perceptions of their learning experience and, in the case of the Spring Quarter experimental students, their perceptions of the value of the multimedia materials.

The students could not be assigned randomly to the three classes, which meant that any differences found among the groups on the criterion variables might be attributable to some systematic difference on other variables such as academic aptitude, motivation, or disposition toward learning. Therefore, each quarter before classes began, all students were pretested on a variety of background variables and personal traits or attitudes commonly known to influence learning behavior. Measurements

of the variables were obtained from a variety of sources, including the School and College Ability Test (SCAT), the Tests for Cognitive Factors (French, Ekstrom, & Price, 1963), the Omnibus Personality Inventory (Heist & Yonge, 1968), and an omnibus student survey instrument, Survey of Engineering 45, especially constructed for the project.

Important background variables included:

1. Academic Aptitude, measured by the School and College Ability Test (SCAT II). This is a standard measure of academic aptitude comparable to the Scholastic Aptitude Test (SAT), or the American College Testing Program (ACT). The SCAT has scores for verbal ability (V), mathematical ability (M), and a total score. It was administered to each incoming student under supervised conditions by the University Counseling Center.

2. Socioeconomic Status, measured by level of father's occupation obtained from the Survey of Engineering 45. Father's occupation is a major indicator of socioeconomic status. Socioeconomic status, in turn, denotes a complex of values and environmental conditions pertinent to the learning situation. As a result, an index of socioeconomic status was derived from the student questionnaire so the relationship of other variables could be examined with this factor taken into account.

3. Flexibility of Closure (Cf), measured by several of the Tests for Cognitive Factors. Tests of flexibility of closure require the subject to identify one or more given configurations in a perceptual field containing irrelevant or distracting material. The specific test chosen to measure this ability was the Hidden

Figures Test, a high level difficulty test which requires the subject to discern a specified geometrical pattern out of five in a complex pattern. Both this and the Visualization Test, noted below, measure traits deemed highly relevant to engineering aptitude since they presumably indicate field independence, ability of mechanical movement, and mechanical comprehension.

4. Visualization (Vz), measured by several of the Tests for Cognitive Factors. The subject taking these tests must rotate, turn, fold, or invert representations of objects or their parts on the basis of specific directions and then compare the resultant manipulated representations with drawings. The specific test used to measure this ability was the Form Board Test which requires the subject to discern which of five shaded drawings of pieces will form a specified outline when fitted together.
5. Thinking Introversion (TI), a scale from the Omnibus Personality Inventory (OPI), which measures the subject's preference for reflective, abstract thinking, particularly in the area of art, philosophy, literature, and music.
6. Theoretical Orientation (TO), from the OPI, measures the subject's disposition toward critical, analytical thinking and scientific inquiry and interests.
7. Complexity (Co), from the OPI, measures the subject's tolerance for the ambiguous, openness to new experiences, and general intellectual curiosity.
8. Autonomy (Au), from the OPI, measures the subject's degree of

flexibility and independence of thinking, openness to others and their ideas, and freedom from exclusive reliance upon authority,

9. Practical Orientation (PO), from the OPI, measures the subject's inclination toward material things and pragmatic thinking rather than the intellectual, ideational, or idealistic.

A review of the original sources of the scales or measurements used indicate that they possess reliability and validity generally beyond that which most psychometricians consider acceptable.

Figure 1 constitutes a schematic of major variables examined according to the research design of the evaluation. On the left side of the figure are noted major control or background variables. The two-way arrows between them indicate that they are liable to interact among themselves; that is, to be interrelated. Singly, or interdependently, they pertain to the individuals in the study groups, and might be expected to influence their learning behavior quite apart from the media "treatment", indicated by the combined arrow impinging on the three groups. Of primary concern, therefore, was to learn if the three groups differed systematically in the outcome or criterion variables after treatment in a way that could not be accounted for merely by the control variables.

The original intent of the research design was to conduct a form of multivariate analysis of variance so that the interaction of the variables could be examined in a way that any unique relationship between the experimental "treatment" and the outcome, criterion variables, could be clearly distinguished. As it turned out, however, the three study groups did not differ on the "control" variables either with statistical significance or even in a tendential manner. (This included the questionnaire

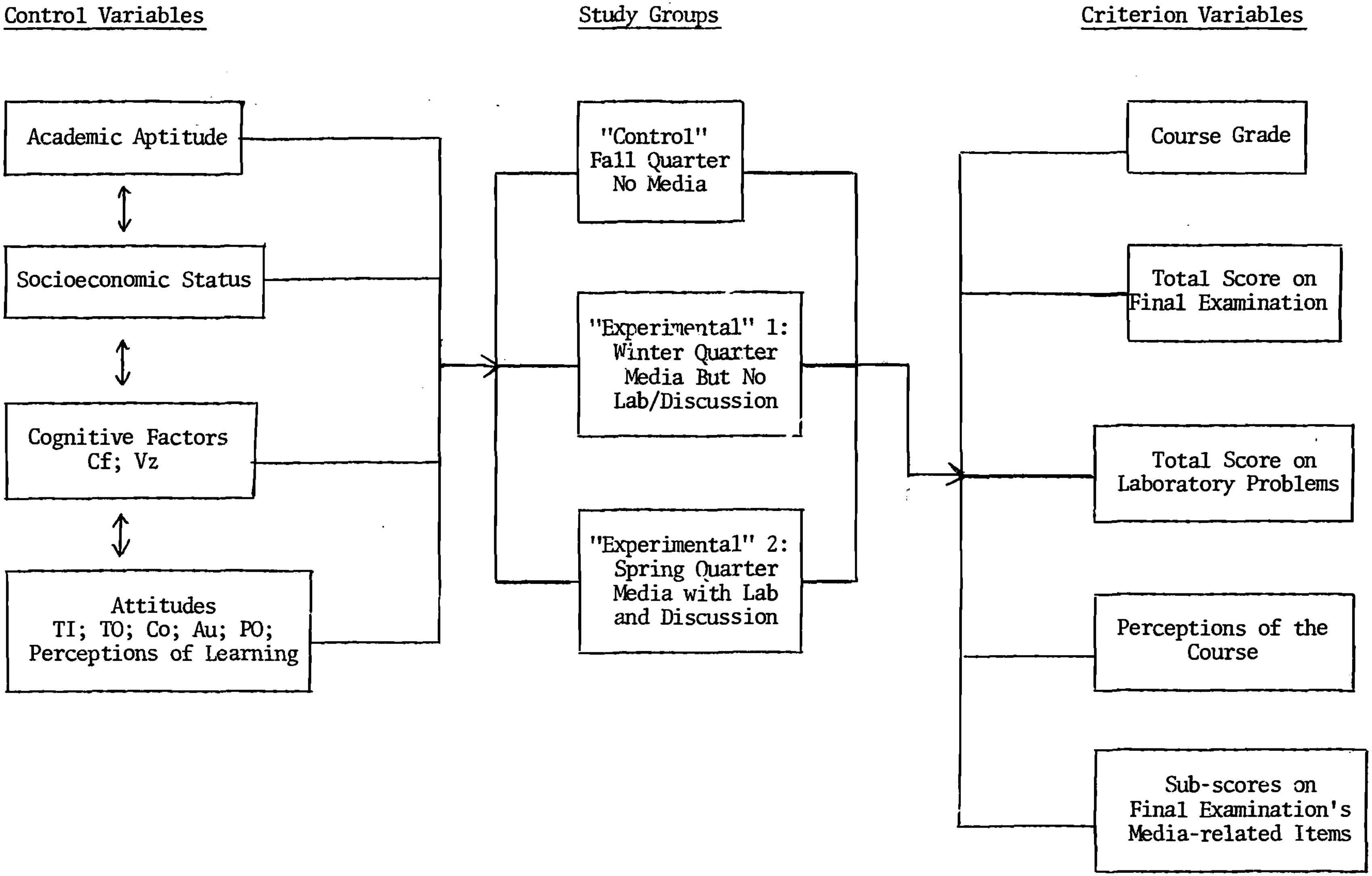


Figure 1. Schematic of the Basic Research Design for the Evaluation of Engineering 45

variable regarding whether they learn best through visual aids.) Consequently, simple analysis of variance for unequal numbers was used to compare the three groups on the scored criterion variables, and chi-squares determined from contingency tables for the sociometric questionnaire data.

RESULTS

Examination scores. The three groups of students did not differ in their total final examination scores, total scores on laboratory problems, or grades. For example, the total final examination scores for the Fall, Winter, and Spring Quarter were, respectively, 338, 345, and 336. The F ratio indicating the statistical significance of the differences among the variance of the distribution of three sets of scores was almost at the zero level: 0.41. The difference in the variation of laboratory problem scores and grades were comparable to those of the final examination. Apparently the multimedia techniques did not contribute uniquely to the overall performance of the students as measured. The story does not end so conclusively or simply however.

Media-related scores. Table 1 shows the 35 items on the final examination that were related to the multimedia instructional materials together with the mean item scores obtained by each group, the F ratios resulting from the analysis of variance of the three groups' scores on each item, and the statistical significance of each F ratio. All tables are contained in Appendix B.* The numbers under the Item column of Table 1

*Students' occasional failure to respond to individual items caused the sample numbers to vary slightly among some tables.

refer to the specific items contained in the final examination which may be found in Appendix C.

The scores of the three groups were significantly different on 19 out of the 35 items, or in a little more than half (54%) of the cases. Eleven out of 19 significant differences (60%) were in the predicted, desirable direction. Five of the differences were in the reverse of the predicted direction, and three were curvilinear in nature. To state the proportions in another way one sees that out of the 35 media-related items, the scores of the 3 groups were significantly different in the predicted direction in 31% of the cases, in the reverse direction in 14% of the cases, and curvilinear in 9% of the cases.

The evidence indicates a trend toward a positive relationship between multimedia instruction and performance on media-related examination tasks. The relationship is certainly not perfect, however, which suggests that the exceptions to the expected outcome warrant close scrutiny. For this purpose the items that resulted in the groups' scoring in a reversed or curvilinear direction are indicated by the arrows next to the related significance level notations in the right column of the table.

Instructor "A" was responsible for the course material that contained the first eight media-related items in the final examination. Of these, only one resulted in significant differences in the predicted direction among the groups. Yet, three of the five items which resulted in significantly reversed scores were among these first eight items. Instructor "C's" materials covered only four of the media-related items. Of these, only one resulted in significant differences in the scores of the three groups, and these were curvilinear, favoring the Winter Quarter group, but not the Spring Quarter groups.

ERIC

Instructor "B's" materials covered 23 of the 35 media-related items. Two of the items resulted in significantly reversed differences, and two in curvilinear scores out of a relatively large pool if items. Ten of the 23 items resulted in predicted significant differences.

These findings are open to a number of interpretations. But at the least, several points seem clear. There is indication that many of the multimedia materials may be producing intended effects in learning behavior. At the same time, when the materials are related to items which resulted in insignificant or unpredicted results, the materials themselves need further examination for their clarity and their value in general.

Instructional presentation also merits investigation. Perhaps the subject matter covered in the units pertaining to the first eight and last four media-related items is not amenable to effective multimedia presentation. But it is just as likely that the way the instruction was handled could have rendered the media materials relatively ineffective.

One other interpretation seems clearly possible in this context: If the differences in content achievement were attributable solely to the instructor then it is not apparent why instructor "B's" Fall Quarter class did not do as well as the others, nor is it clear why his Winter Quarter class did as well on the media-related items as his Spring Quarter class, since the Winter Quarter class had only limited access to the materials without benefit of discussion. Evidence of this kind, however, lacks conclusiveness without benefit of further interpretation.

This last point raises yet another issue. Although "t" tests were not computed comparing the differences between the Winter and Spring Quarter classes exclusively, simple inspection of Table 1 indicates that

the Winter Quarter students generally performed as well as and sometimes better than, the Spring Quarter students on the media-related items. Whatever special "treatment" presumably was provided in the Spring Quarter by way of preparation, discussion, and review had no discernible effect in the present context. If continued, its format, content, process, and values should be made evident.

The predicted differences that did result obviously were not enough to affect the total scores of the groups on the final examination. This may be true partly because the reverse scores may have negated the effect of the predicted scores and partly because the media-related items were too few to have contributed manifestly to the overall variance of scores on the final examination as a whole. There is some promise that this situation could change with the incorporation of more media material pertinent to more of the course content

Perceived learning. How a student feels about his learning can be as important as what he is known to have learned from specified measurements. Tables 2 through 6 indicate the students' perceptions of their learning as indicated from the survey instrument they completed at the end of each quarter (see Appendix D). In most cases the students were asked to express their opinions about each unit of the course--Mechanical, Electrical, and Concrete properties--as well as the course as a whole.

Chi-squares were computed to determine the statistical significance of differences between groups and categories of responses in the table. Few differences pertaining either to the course units or the whole course were significant, with the 5% level considered the minimum criterion. Nevertheless, some apparent trends did emerge from the data. Table 2 serves as a good case in point.

ERIC

The students were asked to rate how informative they felt Engineering 45 to be at the end of each quarter. A scale with category "1" indicating "very informative" and category "2" indicating "not informative", was used. Half of the students considered the course informative, combining the first two categories. This, of course, means that half did not, a matter that perhaps should not be taken lightly. In reference to all but the Electrical unit the Winter and Spring Quarter students (who had access to the multi-media materials) considered the course to be informative in greater proportion than the Fall Quarter students. Combining the first 2 categories in reference to the entire course, 41% of the Fall Quarter, 49% of the Winter Quarter, and 64% of the Spring Quarter students considered the course informative, which is precisely the direction of responses predicted.

A majority of students felt that they understood the course's objectives by the end of each quarter, indicated by the combined response to categories 1 and 2 in Table 3. Still, with the interesting exception of the Winter and Spring Quarter students' references to the Concrete unit, generally at least one third of the students were not positive about having understood the course objectives (categories 3 and 4). The Electrical unit was again the exception; otherwise for all units and the course as a whole the Fall Quarter students in least proportion felt that they understood the objectives. Proportions of Fall, Winter, and Spring Quarter students responding to the first 2 categories for the entire course were, respectively, 55, 64, and 68%. Chi-squares indicated overall statistically significant differences for each unit and the whole course in Table 3.

Perhaps because of a sense of confidence or a sense of realism on the part of the students, generally less than one third felt that the course

pointed out gaps in their comprehension of the material, regardless of class or unit considered. This is particularly the case in reference to the course as a whole, where the Fall Quarter students in greater proportion than the others considered gaps in their understanding to be pointed out often, as indicated in the combined responses in the first two columns of Table 4. Of course, possibly the innovations in the Winter and Spring Quarters closed the gaps rather than simply indicating them.

Whatever the gaps in their learning, a majority of the students felt that Engineering 45 increased their theoretical understanding of the content of the course, as is indicated by the responses to the first two categories in Table 5. Depending upon the quarter or the unit in reference, between 52 and 74% of the students felt that the course made a positive contribution to their understanding. Again, this left a sizeable minority that did not agree. And, once again, the Electrical unit was the exception in that the Fall Quarter students in greater proportion than the Winter or Spring experimental quarter students considered the course to contribute positively to their theoretical understanding. Between 62 and 68% of the students in all three classes felt that the course as a whole contributed positively to their understanding. Although differences were nominal in this respect among the three classes, the Spring Quarter students in largest proportion felt the course contributed to theoretical understanding.

The Spring Quarter students also reported in greatest proportion (approximately 44%) at the end of the term that they felt they possessed a great deal of understanding of all the courses they had completed up to that time, as noted in Table 6. Here again, however, differences among the three classes were nominal, and it is not at all clear that Engineering 45 contributed to

the understanding of the other courses the students took or whether this should even be expected. Moreover, a definite majority of all of the students were not very positive about the understanding they had of their major courses generally. But this may very well be a realistic perception of individuals working in complex areas, whether they be professors, practitioners, or students.

Attitude Toward Learning. Learning or understanding of course content does not take place necessarily because the instructor intends it to. Learning also depends upon the disposition with which the student approaches the learning situation, and assessment of that situation must include reference to the contribution the situation has made to the student's disposition toward learning. Such is the subject matter of Tables 7 through 13. The tables may deserve examination as much for the implications they have for the engineering instructional program generally as for their implications regarding the multimedia instruction. Summary findings are that:

(1) A considerable majority of the students (approximately 85%) felt that lecture classes were superior to discussion classes, although "strong" agreement to this position was expressed by less than one-third of the students (Table 7). Only nominal differences existed among the classes. Apparently the personalization and individualization of instruction advocated by many contemporary students was not a concern of these engineering majors. Under the circumstances, possibly the introduction of new teaching modes to students of this kind may require first familiarizing them with the modes themselves for subsequent maximum instructional effectiveness.

(2) A majority of students also agreed with the questionnaire statement that emphasis should be placed on independent study (Table 8). A larger proportion of students, however, disagreed with this position compared with the proportion disagreeing about the superiority of the lecture system. Differences among classes remained nominal, although a noticeably higher proportion of the Spring Quarter students agreed that emphasis should be placed on independent study compared with the other students. A majority of the three classes of students also agreed that they were encouraged to think independently by the course on the whole and in the Mechanical unit (categories 1 and 2 in Table 9). But this was not true for either the Electrical or Concrete units. Questions may be raised about whether the lecture system and prescribed laboratory problems provide the best way to promote independent thinking. Nevertheless, the students generally considered the trait important and by and large felt they were encouraged in this direction.

(3) The students were not nearly so sanguine about their own attention in class (Table 10). Sixty-two % of the Winter Quarter students and 47% of the Spring Quarter students rated their attention positively in reference to the Concrete unit, combining categories 1 and 2. Otherwise, only a minority of students felt this way, regardless of class or unit. With the exception of the Electrical unit, the Winter and Spring Quarter students in greater proportion than the Fall Quarter students rated their attention positively. Without comparative data to indicate otherwise, the overall attention reported by the students may be as good as can be expected from students generally, even if not ideal.

ERIC

(4) A majority of the students in all units and for all classes felt positively that Engineering 45 encouraged them toward critical thinking in the solution of problems (categories 1 and 2, Table 11). Omnibus Personality Inventory scores, to be discussed subsequently, suggest that relatively few of the students are disposed towards independent or critical thinking as commonly defined in behavioral terms. Still, in the students' terms these traits were generally perceived or encouraged.

(5) The students rated Engineering 45 unevenly in terms of how stimulating they considered the course, and the value they placed upon it compared with other engineering courses they had taken (Tables 12 and 13, respectively). The overall chi-squares were statistically significant in all cases, however. And--with the persistent exception of the Electrical unit--the Winter and particularly the Spring Quarter students in greater proportion rated the course positively on these two variables. Moreover, some marked differences occurred. For example, in reference to the Mechanical unit, 48% of the Fall Quarter students rated the course as stimulating (Categories 1 and 2 combined), compared with 57% of the Winter Quarter and 74% of the Spring Quarter students. The figures were very similar for the Concrete unit; corresponding figures for the course as a whole were 20, 28, and 47%. A minority of students placed a very positive value on Engineering 45 compared with other courses they had taken in the College of Engineering. The minority was large, however, as reflected in the responses to the entire course, 39% of the Fall Quarter students placed positive value on the course, compared with 42% of the Winter Quarter and 51% of the

Spring Quarter students. All in all, then, relatively few students were very negative about the course, and a significant proportion were quite positive, particularly among the Spring Quarter students.

A natural interpretation of Tables 12 and 13 is that the media techniques did contribute to the students' finding the course stimulating and of value compared with other courses. Another interpretation might be that the instructors were trying harder or that they were more practiced by the end of the year--although the latter point weakens in face of the fact that they had experience teaching the course previously. The possibility that the instructors might have elicited more favorable impressions from their students by trying hard might also bear on the students' better performance on the selected media-related items noted in Table 1.

Although the causes of differences in performance and perception among the three classes cannot be determined precisely, there is good reason to consider them as being at least in part influenced by the media techniques. But even if this should not prove true according to the present criteria through replication and additional evaluation, there remains the issue of how the students regarded the materials apart from content related performance. The data in Table 14 show that the Spring Quarter students who used the media laboratory almost unanimously considered the experience favorable.

The students were asked to evaluate three slide sets (examples from which may be found in Appendix A): Crystal Structure; Planar Technology, and Transistor Fundamentals. At least 95% of those students who filled out evaluation forms found the slides helpful regardless of the set of slides; at least 92% found them easy to understand; at least 95% had a favorable overall impression of the experience. At least 84% of the students also found the related text

accompanying the slides easy to understand; and, from an item not shown in Table 14, only in a very few cases did the students suggest deleting a slide. The fact that the students were so appreciative of the experience may enhance their learning and performance in ways yet to be ascertained. The data in the last three columns of Table 14 also suggest that more measureable learning might have taken place under the given circumstances had the students taken more advantage of the experience offered them.

Of the 74 Spring Quarter students who took a final examination, only 62 completed evaluation forms on Crystal Structure, 19 on Planar Technology, and 25 on Transistor Fundamentals. Indications are that most students must have viewed the slides independently without completing evaluation forms, other than the one on Crystal Structure. Of those who did go and who filled out evaluation forms, only a minority reviewed any set of slides more than once. Moreover, they generally viewed the slides alone even though the few who did have other students with them usually found discussion of the slides to be helpful.

To encourage candidness, the students who filled out evaluation forms were unidentified. Had they given their names, a comparison of their media-related examination scores with those who did not make full use of the laboratory experience might have implied much more about the effectiveness of the technique. This is particularly true in reference to the students who reviewed the same set of slides more than once. In the meantime, indications are that more students should be encouraged to make greater use of the media laboratory in the future.

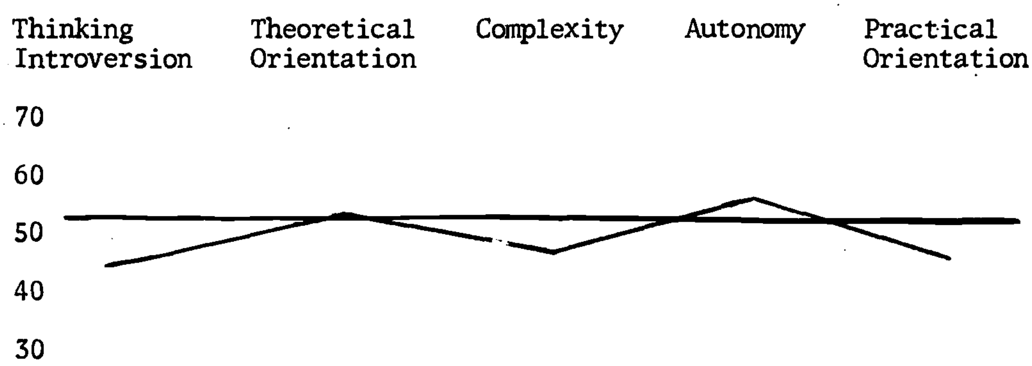
BY-PRODUCTS

An extensive pool of data was obtained from the students, not all of which, in the end, was used in the formal evaluation. The data will continue to be of

ERIC

use in future evaluation, however, and they comprise "by-products" of the project important to a more comprehensive evaluation of the program that goes beyond the handling of Engineering 45, as such. Included in the products are an assessment of student characteristics which have implications for the entire engineering program, and the basis for devising measurements to predict such important outcomes as achievement, persistence, and creative or scholarly potential.

Student characteristics. Figure 2 shows graphically the personality characteristics of the three classes combined as determined by selected scales from the Omnibus Personality Inventory. The scales, described in the Introduction, were originally included as control variables. They were omitted from the three-class evaluative analyses since they did not distinguish among the classes in a way that would have suggested interaction with the "treatment". The students' scores on the scales bear closer scrutiny, however, in terms of what they suggest about Berkeley engineering students generally and their educational program.



	Thinking Introversion	Theoretical Orientation	Complexity	Autonomy	Practical Orientation
Stnd. $\bar{X}$	44.12	50.2	46.4	53.5	45.4
Raw $\bar{X}$	21.5	20.2	14.0	27.5	12.9
S.D.	8.6	6.9	6.1	10.0	6.0

Figure 2. Standard mean scores of Engineering 45 students on selected OPI scales (N=236)

Depicted in Figure 2 are the standard mean scores of the total sample of Engineering 45 students on the scales at hand, the raw means and standard deviations from which the standard scores were derived, and the graphic representation of the standard means in reference to the OPI normative sample drawn from freshman classes across the country. Standard scores permit direct comparison of scales which in raw form differ in the number of items that they comprise. For all scales 50 is the standard normative mean and 10 is the standard deviation, meaning that approximately two thirds of the normative sample obtain a standard score between 40 and 60 on the scales.

Compared to the normative freshman sample the engineering students show a lack of disposition towards abstract, reflective thinking and a lack of interest in ideas related to literature, art, music, and philosophy, as indicated by their mean Thinking Introversion score. Their Theoretical Orientation score equals that of the normative sample, indicating an interest in analytical scientific thinking and affairs comparable to that of the "average" freshman across a variety of colleges. The engineering students' Theoretical Orientation scores are surprisingly low considering they reflect those of a select group of students in a select, research-oriented department. The relatively low mean Complexity score indicates a lack of tolerance for ambiguity, critical thinking, and intellectual curiosity compared with the "average" freshman. On the other hand, the engineering students show greater disposition toward independent flexible, objective,and open-minded thinking than the average freshman, indicated by the Autonomy score. They also show less preoccupation with material gain and the prurely pragmatic as indicated by the Practical Orientation score. Both the Autonomy and Practical Orientation scores are the reverse of what has been found for engineering students

typically (Cf. Heist, 1968; Snyder, 1968; Trent, in press, 1970; Trent & Medsker, 1968).

This group of engineering students' Autonomy and Practical Orientation scores suggests they are open to new ideas and that they are looking for more than mere technical competence, unlike so many technological majors who are quite authoritarian and inflexible in outlook and who are preoccupied with vocational training. The practioner-oriented program, therefore, will probably not be sufficiently satisfying for these students. Yet, they were not disposed toward interest in ideas, scientific, critical thinking or intellectual curiority as measured by the other scales. Perhaps given the relatively high Autonomy scores, they could change their attitudes on the other dimensions if they were presented with the right educational experiences and environment; depending upon the Engineering program's objectives, this possibility is worth considering. This is true especially since studies reported in the OPI manual and elsewhere (Heist, 1968; Heist & Yonge, 1968; Snyder, 1968) indicate that combined high scores on the Theoretical Orientation, Complexity and Autonomy scales, along with relatively low scores on the Practical Orientation scales, are predictive of creative, scientific scholarship, surely a desired outcome of an engineering program such as that at the University of California at Berkeley.

In order to examine more closely characteristics of the students manifesting different degrees of intellectual, scholarly or creative disposition, they were assigned to an Intellectual Disposition Category (IDC) based upon their combined scores on relevant OPI scales. An adaptation of the scoring scheme for determining IDC scores noted in the OPI Manual (Heist & Yonge, 1968) was used. The Manual provides for eight categories; they were combined

into four groupings for the purpose of the present analyses. The method for determining the IDC scores may be found in Appendix E.

In general, the students must have averaged above a standard score of 61 on the Thinking Introversion, Theoretical Orientation, and Complexity scales and above 54 on the Autonomy scale to be placed in the first category, representing a high commitment to intellectual, scholarly, and creative pursuit. Students with average scores of 53 in the first three scales and above 44 on the Autonomy scale fell in category two. Average scores above 41 on the first three scales and below 55 on the Autonomy scale fell in category three, and average scores below 41 fell in category four, representing an aversion toward intellectual and creative pursuits. Variations for specific scales are noted in the appendix.

Table 15 shows the results of the categorization. Few of the students showed any real predilection for creative, scholarly endeavor, indicated by the five % of the sample that scored in the first category. The 29% of the students who scored in the second category manifested some interest in intellectual and creative development, but evidently this was not true of the 64% of the students who scored in categories three and four.

Considerably more of the engineering students placed in the lower two Intellectual Disposition Categories than the Manual's normative data indicate would be expected for students on the whole. Nevertheless, an observable group of engineering students showed a marked interest in creative and intellectual endeavor. Moreover, the students who scored in category two, and who represented nearly 30% of the sample, might be moved toward a greater intellectual disposition.

Something can be said of differences in achievement and attitudes among

the students classified by the Intellectual Disposition Categories that may indicate some effects of increased intellectual disposition among engineering students. For this purpose the four groups were compared on the following variables: (1) their scores on their final examination's media-related items; (2) their perception of their relationship to their environment in the College of Engineering; (3) their perceptions of the benefits of education; and (4) their perception of the occurrence and desirability of changes in society.

The variables were chosen in order to gain some notion of the differences in learning behavior of engineering students of different levels of intellectual disposition as well as their attitudes toward their education and from different strata of society. These variables were deemed important for the information they could contribute regarding the relationship between engineering students' dispositions and what they may gain from and contribute to their education as well as society, apart from their profession in itself.

Information of this kind, in turn, is useful in deciding the directions and objectives of educational programs--including the decision regarding the advisability of deliberately encouraging the development of intellectual disposition among engineering students. Tables 16 through 20 contain summaries of the results of the analysis of the Engineering 45 students in this context. Data regarding all variables except the final examination item came from the Survey of Engineering 45 instruments shown in Appendix D.*

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*These data are based on the responses of the 222 students who completed all of the OPI scales rather than the total number of 236 students who took final examinations in Engineering 45. Analysis of variance was employed to test the significance of differences among the four groups on the variable considered. The small frequencies found in Groups I and IV, however, raises some doubt about the legitimacy of this type of analysis in the present instance. Therefore the findings may better be regarded as suggestive rather than conclusive. Alpha coefficients computed for the indices discussed--

(1) Media-related items. Apparently disposition toward learning, ideas, and creative interests have little to do with the performance required by the media-related items in the final examination. Essentially no differences existed among the groups on these variables, and perhaps that is as it should be. On the other hand, more might need to be done to encourage students to apply their course knowledge and understanding independently and to build upon the knowledge gained in the course. Items designed to assess these capabilities no doubt would have distinguished among the four groups, although this is not indicated by the single item noted in Table 16 that did differentiate significantly and consistently among the groups. Item 8e of Appendix C appears to ask mostly for recall in constrast, say, to item 18, which not only calls for the recall and understanding of physical concepts but also of their formulaic application.

(2) Desired environment. What a student learns can, of course, be affected by what he wants to learn, and how. Table 17 indicates those aspects of the learning environment that the four groups of students perceived as desirable. The variable represents an abridgement of Pace's (1969, 1963) five primary CUES scales, described in Appendix F. The abridged scales, found on pages 5 and 6 of Survey II in the Appendix, comprise four critical items that correlate highly with the original scales.* The groups did not differ

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drawn from the Higher Education Evaluation Kit of the Center for the Study of Evaluation--indicated acceptable reliability (See Pace, Trent, & Morey, 1970).

*Normally the scale's scores are based upon a consensus of student's perceptions of their college environment according to each item. In this instance, each student was given a score 0 to 4 on each scale, depending upon the number of items he checked as desirable.

on the Practicality or Community scales (not shown in Table 17). Expectations were that Groups III and IV more than the others would be concerned with the practical matters pertaining to academic issues and authority, manifest in the first four items on page 5 of Survey II. No judgements were made about differences on the Community scale, comprised of the next four items dealing with supportive relationships among students and faculty. As anticipated, the more evident and significant differences among the groups occurred on the Awareness scale, the first scale noted in Table 17, comprised of the third set of four items. High scores indicate the students' strong desire to participate actively in their education and to have ample opportunity to deal with esthetic, political, and intellectual issues. The means and standard deviations indicate that a majority of students in Group II and especially Group I endorsed at least three of the items and that many of these students endorsed all four of the items. They were also more likely to find desirable principles and procedures conducive to a high degree of scholarship. This is evident from their Scholarship scores derived from their responses to the last four items on page six, indicating an interest in intellectual challenge, and high standards of achievement, study, and scholarly communication. Groups III and IV showed a greater preoccupation with conformance to good conduct, rules, and regulations, manifested by their scores in the Propriety scale, derived from the four items on page six preceding the Scholarship scale.

(3) Benefits of education. Three indices assessing students' views on the major benefits of education were derived from the items included on pages 13 and 14 of the Survey of Engineering 45 under the heading "Views on Education." One had to do with stress on vocational development, including concern over training for jobs, specialization, terminology, and parts of

fields of knowledge and improved social and economic status as indicated by items 1, 2, 14, and 17 of the "Views." The groups did not differ on this index, corroborating their similarity regarding the desirability of a practical college environment, discussed above. The data in Table 18 suggest that they showed a tendency to differ on the Personal and Social Development Index dealing with concern over skill in interpersonal relations, personal understanding and development, appreciation of individuality and independence, establishment of friendships, and tolerance and understanding of others, as indicated by the "Views" items 5, 6, 12, 13, and 16. The students checked "1" if they considered the item a "very important" educational benefit to "4" if they considered it "very unimportant." The lower the index score, therefore, the greater the importance that was attached to its items as educational benefits. This means that there was an observable relationship between Intellectual Disposition Category and stress placed on the benefit of personal and social development with students in the highest category (I) placing the greatest importance on these benefits, and students in the lowest category (IV) the least. The differences were not marked, however; in fact, they did not quite reach the five % level of statistical significance. The groups did differ significantly on the third Index, Liberal Education. The Index comprised items 3, 4, 7, 8, 9, 10, and 11, having to do with literary appreciation, cultural awareness, critical thinking, esthetic sensitivity, effective communication, scientific appreciation, and quality of civic and political life. The highly significant statistical differences shown in Table 18 indicate that those students highest in intellectual disposition were the most likely to consider the items comprising the Liberal Education Index as important benefits of their education.

(4) Changes in society. One objective of a College of Engineering such as that at Berkeley is to train students to be competent engineering scientists. But another viable objective may be also to assure that the students become aware of changes in society, their possible contribution to these changes, and the possible positive and negative repercussions of the changes and their contributions to them. With this thought in mind the students were asked to respond to the item contained on pages three and four of Survey II (Appendix D). The items were constructed from the conclusions of various social critics regarding changes occurring in the social, political, occupational, and economic patterns of society. The students were asked to indicate which changes they agreed were occurring and, in selected instances, which changes they felt were desirable. Tables 19 and 20, respectively, summarize the results. Only three items distinguished among the groups with statistical significance: agreement that there is an increasing movement toward intercity government; that business and industrial organizations are moving more toward callaborative rather than competitive relationships; and that business is becoming more international in nature. The groups appeared to differ on four other items noted in Table 19, but their F ratios did not quite reach the five per cent level of significance. Total scores, determined by the numbers of items on the two pages checked "generally true", distinguished among the groups beyond the one per cent level of statistical significance. Although the differences were not striking, particularly by individual items, a relationship existed between Intellectual Disposition Category and Changing Society Index scores, with those students highest in intellectual disposition most agreeing to changes occurring and those lowest in intellectual disposition least agreeing. Agreement to the desirability

of the changes distinguished among the groups more than acknowledgement of the changes. Half of the items scored for desirability distinguished among the groups, including the item on the devaluation of individual success over group achievement which did not quite reach the five percent level of significance.* They included the endorsement of broad political participation, self-expression, interdependence of individuals, the influence of scientists, intercity government, and the devaluation of individual over group attainment. Curiously--and for no readily discernible reason--the first Intellectual Disposition Category group was least inclined to find a movement toward industrial collaboration desirable. Otherwise, those students highest in intellectual disposition were most likely to consider the presumed changes in society desirable, and the students lowest in intellectual disposition were the least likely to find them desirable. This was particularly true for the items taken as a whole, indicated by the F ratio for the total scores.

In sum, those relatively few students who showed potential for creative and scholarly practice, did not differ from the others in performance on the media-related items; neither did they differ in practical concerns regarding their college environment or educational benefits. But they did differ in broader concerns. More than the other students they preferred an environment that would not only give them practical training but also opportunity for experience with a wide range of cultural, esthetic, and social-political issues. They were more aware of possible if not probable changes in society, and more

*Students were asked to indicate the desirability of 15 of the "Changing Society" items. Item 3 was omitted from the scoring, however, because it seemed ambiguous for this purpose.

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open to them. Questions that result are whether it is desirable to recruit more students of this calibre and to provide them with more of the experiences they would prefer in addition to their heavy schedule of engineering science courses. These are not new questions, but they may gain in relevance in the face of the nature of contemporary society and the role of the engineering scientist in society.

Measurement and prediction. Currently underway are analyses which, when completed, should contribute information basic to determining what kind of student should be recruited in reference to the observed or desired outcomes of the program. The analyses test the reliability, independence and, to some extent, the predictive validity of a number of measurements embedded in both parts of Survey of Engineering 45. Some of the measurements were drawn from the Higher Education Evaluation Project of the Center for the Study of Evaluation for their relevance to the present project. Others were developed specifically for the purposes of the project.

They include indices or scales to measure the following:

(1) School involvement
(2) Study habits
(3) Academic problems
(4) Academic motivation and aspiration
(5) Learning sets
(6) Learning styles
(7) Perception of education benefits
(8) Perception of subject field areas
(9) Perception of college and department environments
(10) Preferred environment

(11) Perception of the changing society

(12) Disposition toward the changing society

(13) Personal traits including Independence of Thinking, Scientific Disposition, Intellectual Disposition, Self-esteem, and Anxiety

(14) Vocational perception

(15) Perception of engineering

(16) Interest in engineering

Once fully assessed for acceptable reliability, independence from one another and from other measurements such as the Cognitive Factors and Omnibus Personality Inventory scales used in the project, the new measurements will be tested for their ability to predict certain "target" groups. These include students with a disposition toward creative scholarship, high achievers, students rated by their peers or professors for academic and developmental excellence in their field, and "defectors" from the field who leave engineering for reasons other than lack of academic aptitude.

The last analyses will be enhanced by a follow-up of the students investigated in the project who, for the most part have just completed their junior year of college. Additional follow-ups of the students after graduation should yield information critical to the understanding of factors related to outcomes of college such as varying degrees and types of the graduates' accomplishments in their professional activities. This information, added to the existing data base, would have great bearing on recruitment and curricular policy and development.

CONCLUDING RECOMMENDATIONS

The data that resulted from the Engineering 45 Learning Study suggest several possibilities indicated by the following recommendations:

1. Extension of multimedia techniques. The evidence--although inconclusive--was that the multimedia techniques adopted for the Engineering 45 Project may well have contributed positively to students' content mastery and attitudes toward learning in selected areas. Clearly, the students appreciated its techniques regardless of their subject mastery. Therefore, the recommendation is that the techniques be extended to cover many more content areas both within and beyond the course at hand.

2. Expansion of the use of the techniques. Most of the students who had access to the media laboratory and who filled out evaluation forms indicated that they reviewed the slide sets only once outside of class and also that they rarely discussed them with others. Had the students reviewed each slide set several times and determined their understanding of them through discussions with other students, quite possibly they would have learned much more from the materials than they did, compared with the "control" group. Therefore, the recommendation is that students in future make repeated use of the slide sets and test their understanding of them through discussions with fellow students and instructors.

3. Instructional modes. The data indicated the possibility that students' subject mastery varied according to the instructor involved. Indications were that the students were not oriented to make the most of a multimedia course, nor of one involving discussion techniques apart from the traditional lecture and laboratory experience. Yet, the student generally expressed an appreciation for independent study, theoretical understanding and critical thinking.

Whether they understood the nature of these functions, however, or whether they had the opportunity to participate or develop in these areas is unclear. The only evidence on the latter subject is that the students scored relatively low on measurements related to theoretical and critical thinking compared with a normative group of freshmen. The recommendation, therefore, is that a continued and intensified examination be made of the entire curriculum to ascertain the extent to which the faculty are in situations where they can best make use of their teaching talents; the extent to which faculty and students are prepared to implement positive innovations; the extent to which the curriculum offers opportunity for independent study, creative research, and development of theoretical and critical assessment; and the extent to which the curriculum meets the department's objectives generally as indicated in the final recommendations.

4. Additional evaluation. A number of issues remain unsolved in the Engineering 45 Learning Study. They include: the capability of different instructors to make effective use of media techniques; the effects of students making repeated use of a comprehensive set of media materials, and testing out their understanding and ability to apply their understanding through discussion methods; the effects of restructuring the course around the media materials to allow for ample discussion and use of the materials; the reasons why in a few cases the content mastery scores were the reverse of what had been anticipated; the relative value of films versus slides; the interaction and predictive power of the variables of concern, as discussed above; and perhaps most important, the identification of the factors that contribute to students' professional and personal development and, more specifically, factors that are associated with students' making relatively outstanding,

creative, theoretical, and applied contributions to engineering science as they move through their curricula and into their careers. Therefore, the recommendation is that evaluation continue at regular intervals to deal with these and the other issues raised in the discussion of the other recommendations, that the present data base be further examined and built upon for that purpose, and that a professional staff member of the department be released part-time--guided by a consultant versed in this area--to undertake the evaluation to assure that it is accomplished promptly and at critical intervals.

5. Follow-up study. Further investigation of the sample of students studied in the present project in their senior year, and again two or three years after their graduation, would yield information that can be gained in no other way. Such a longitudinal study can provide answers to questions concerning the long-range effects of various instructional modes and techniques; characteristics of students who leave the field of engineering, factors related to withdrawal and the results of withdrawal, and outcomes such as vocational development, professional achievement, and societal contributions, together with educational factors related to these outcomes. The recommendation, therefore, is multifold; namely: that the sample of Engineering 45 students in the project at hand, originally studied in the academic year 1968-1969 be examined again in the Spring Quarter of 1971, presumably their final senior quarter for a majority of the students in the sample; that this study be repeated on the same sample in 1974; that a new study of this kind be initiated with a representative sample of incoming students at regular intervals of every two or three years to keep abreast of changing situations, new student needs or characteristics, and the effectiveness of new programs;

that these studies give direct attention to the issues raised in the present report as well as those urgent issues that cannot be anticipated at the present time; and that a part-time departmental research officer take the responsibility for this research program in the manner noted in the fourth recommendation above.

6. Establishment of objectives. The research to date indicates much about such things as the characteristics of students currently in the College of Engineering, their plans, their interests, their approach to learning, and their educational preferences and objectives. Continued evaluative research could contribute much more of this kind of information, and particularly emphasize what kind of student entering what kind of program leads to what kind of outcome. But major questions remain; these have to do with what kind of outcomes the department desires and, consequently, what kind of students it wants to recruit and what kind of program it wants to offer them. The final recommendation, therefore, is that the College of Engineering establish operational objectives on a consensual basis; that it examine its present programs and students to learn the extent they are conducive to the objectives; that, if and where necessary, it establish new programs and recruitment policies designed to meet its objectives; and that--as recommended above--it establish an evaluation program designed to assess the effectiveness of policy and program implementation in reference to the College's objectives.

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APPENDIX A

Films and Slide Sets Developed for
Engineering 45 Learning Study

Title	Content	Development
Films:		
1. Crystal structure	Crystallography of hexagonal close packed structure. (Used in Material Science lecture section on crystallography).	Sequence and visuals developed by faculty and Mr. Richard Davis, a high school Chemistry instructor familiar with media development; animation and film production by University Extension Media Center.
2. Transistor fundamentals	Energy levels and use of PN and NPN junctions in semi-conductors. (Used in Electrical Engineering lecture section on semi-conductors).	Sequence and visuals developed by Prof. Theodore Kamins, film produced by University Extension Media Center.
Slide Sets:		
1. Crystal structure	Crystallography of hexagonal close-packed, body-centered cubic, face-centered cubic and diamond cubic structures. (Used in library in connection with Material Science section on crystallography; example follows).	Text and visuals developed by faculty and Mr. Richard Davis; slides produced in part by Department and in part from Crystal Structure film by University Extension Media Center.
2. Transistor fundamentals	Energy levels and use of PN and NPN junctions in semi-conductors. (Used in library in connection with Electrical Engineering section on semiconductors; an example follows).	Text and visuals developed by Prof. Theodore Kamins; slides made from Transistor Fundamentals film by University Extension Media Center.
3. Planar technology	Construction of integrated circuits. (Used in library in connection with Electrical Engineering section on semiconductors).	Text developed by Prof. Theodore Kamins, visuals copied from film Prof. Kamins had; slides produced by University Extension Media Center.
4. Portland cement	Structure and use of Portland cement (Used in library in connection with Civil Engineering section on cement).	Text and visuals developed by Prof. Robert Williamson; slides produced by Prof. Williamson.

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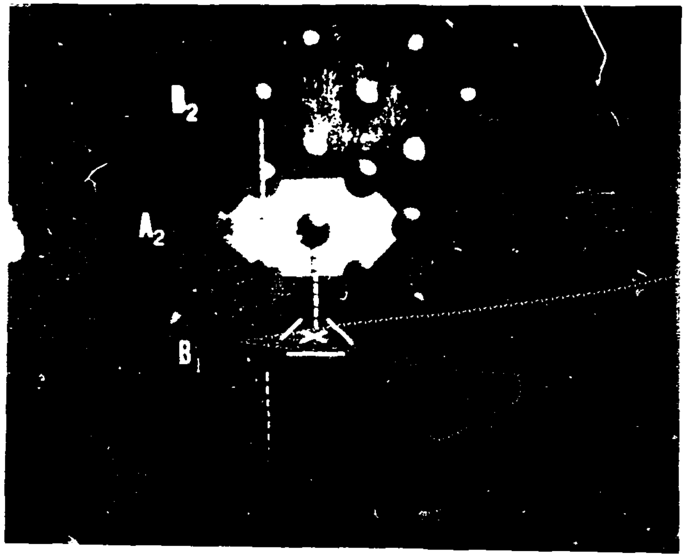
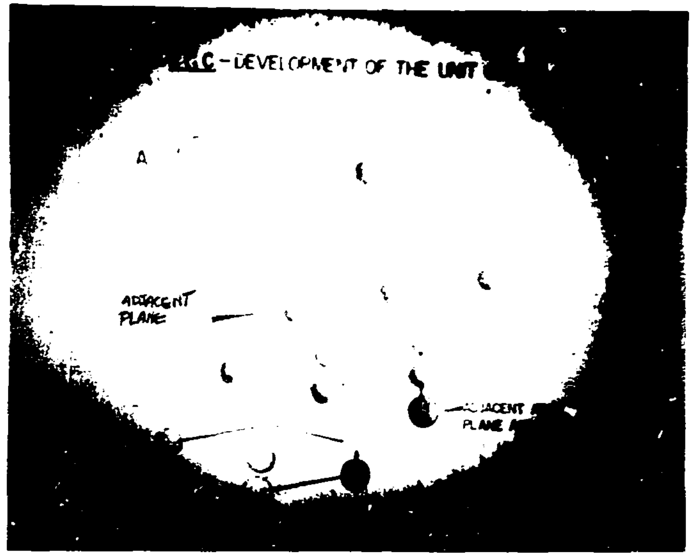
Examples of Slides from Crystal Structure and Transistor Fundamentals Sets

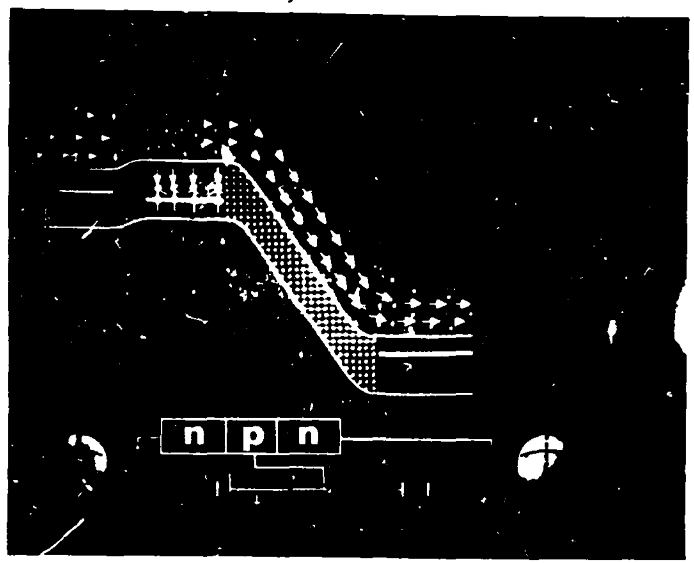


1. From Crystal Structure Set



2. From Crystal Structure Set

3. From Crystal Structure Set



4. From Transistor Fundamentals Set

Appendix B. Data Presentation of Engineering 45 Learning Study Evaluation

TABLE 1

Mean Scores of Engineering 45 Students on Media-Related Final Examination Items

Instructor	Item[a]	Quarter			F Ratio	p	
		Fall (N=89)	Winter (N=73)	Spring (N=74)			
A	2a	3.1	3.9	4.0	12.13	≤.01	
A	2b	2.3	3.0	3.0	2.99	N.S.	
A	4a	2.9	1.7	2.6	5.71	≤.01	←
A	4b	3.5	3.4	3.5	0.13	N.S.	
A	5	3.8	4.0	4.0	0.10	N.S.	
A	7b	1.8	1.7	1.9	1.70	N.S.	
A	8e	1.5	0.9	0.5	46.22	≤.01	←
A	9b	2.3	1.4	1.4	10.87	≤.01	←
B	10a	3.9	3.9	2.4	24.79	≤.01	←
B	10b	1.5	1.8	1.9	5.02	≤.01	
B	10c	1.9	2.1	2.2	2.10	N.S.	
B	10d	1.1	1.5	1.2	3.33	≤.05	→ ←
B	11a	2.5	2.4	1.7	4.39	≤.05	←
B	11b	2.9	3.0	3.8	4.98	≤.01	
B	11c	3.2	3.2	3.6	1.62	N.S.	
B	12a	0.6	0.5	0.6	0.94	N.S.	
B	12b	0.9	0.9	0.9	1.22	N.S.	
B	12c	0.9	1.0	1.0	0.05	N.S.	
B	12d	0.7	0.9	0.8	6.33	≤.01	

TABLE 1 (Continued)

Instructor	Item[a]	Quarter			F Ratio	p	
		Fall (N=89)	Winter (N=73)	Spring (N=74)			
B	12e	0.7	1.0	0.8	9.82	≤.01	
B	12f	0.9	0.9	0.9	0.07	N.S.	
B	12g	0.7	0.7	0.7	1.11	N.S.	
B	12h	0.9	0.9	0.9	0.03	N.S.	
B	13a	3.1	2.8	3.1	4.10	≤.05	← →
B	13b	2.9	3.2	3.4	5.12	≤.01	
B	13c	2.5	2.6	2.7	0.81	N.S.	
B	13d	2.1	2.5	2.6	5.57	≤.01	
B	14a	2.2	2.8	2.9	8.08	≤.01	
B	14b	2.4	2.9	3.0	6.10	≤.01	
B	14c	2.0	2.9	2.7	16.17	≤.01	
B	14d	2.1	3.1	3.0	23.36	≤.01	
C	16	3.6	3.5	3.5	0.07	N.S.	
C	17	2.8	3.1	3.4	1.54	N.S.	
C	18	2.7	3.2	2.5	3.09	≤.05	← →
C	19	1.3	1.1	1.4	0.36	N.S.	

[a]The specific items may be found in the final examination reproduced in Appendix C.

TABLE 2

Extent Engineering 45 Students Considered Their Course Informative in Percent (Post-Test)

Course unit and Quarter	(N)	Very Informative 1	2	3	Not Informative 4
Mechanical					
Fall	(88)	13	28	32	27
Winter	(72)	17	33	31	19
Spring	(70)	17	40	31	11
Electrical					
Fall	(88)	22	35	26	17
Winter	(72)	11	26	36	25
Spring	(70)	13	37	21	29
Concrete					
Fall	(89)	15	12	13	7
Winter	(72)	38	10	7	2
Spring	(70)	27	14	5	3
Entire Course					
Fall	(87)	9	32	45	14
Winter	(71)	10	39	38	13
Spring	(70)	13	51	27	9

TABLE 3

Understanding of Course Objectives Expressed by Engineering 45 Students, in Percent (Post-Test)

Course unit and Quarter	(N)	Very well 1	2	3	Not well 4
Mechanical*					
Fall	(88)	11	34	39	16
Winter	(72)	17	47	24	13
Spring	(69)	23	46	25	6
Electrical*					
Fall	(88)	28	42	19	10
Winter	(73)	11	41	26	22
Spring	(70)	20	27	21	31
Concrete*					
Fall	(87)	21	37	29	14
Winter	(73)	40	43	15	3
Spring	(70)	36	47	14	3
Entire Course*					
Fall	(88)	9	46	34	11
Winter	(70)	3	61	34	1
Spring	(69)	13	55	28	4

*Chi-square indicates significant differences, with minimum criterion = $p<.05$.

TABLE 4

Extent to Which Engineering 45 Students Felt Their Course Pointed out Gaps in Their Comprehension of the Material, in Percent (Post-Test)

Course unit and Quarter	(N)	Very Often 1	2	3	Seldom 4
Mechanical					
Fall	(88)	14	24	35	27
Winter	(71)	4	24	35	37
Spring	(67)	6	24	42	28
Electrical					
Fall	(88)	10	19	40	23
Winter	(71)	9	25	35	17
Spring	(67)	9	24	40	21
Concrete					
Fall	(87)	12	15	46	20
Winter	(71)	3	30	38	16
Spring	(66)	11	23	41	23
Entire Course					
Fall	(87)	6	20	40	21
Winter	(71)	2	14	34	21
Spring	(66)	4	14	31	17

TABLE 5

Extent Engineering 45 Students Felt Their Course Increased Their Theoretical Understand in Percent (Post-Test)

Course unit and Quarter	(N)	Greatly 1	2	3	Did not 4
Mechanical					
Fall	(87)	14	38	32	16
Winter	(73)	18	51	21	11
Spring	(69)	23	39	25	13
Electrical					
Fall	(87)	23	45	20	12
Winter	(73)	21	34	25	21
Spring	(68)	18	35	25	9
Concrete					
Fall	(87)	20	43	24	14
Winter	(73)	26	48	14	12
Spring	(68)	31	40	19	10
Entire Course					
Fall	(88)	14	48	28	10
Winter	(73)	15	49	22	14
Spring	(68)	19	49	21	12

TABLE 6

Amount of Understanding of Major Courses Completed Reported by Engineering 45 Students (Post-Test)

	A Great Deal		Some	
	(N)	%	(N)	%
Fall	(35)	39.8	(53)	60.2
Winter	(29)	40.3	(43)	59.7
Spring	(31)	43.7	(40)	56.3

TABLE 7

Percentage of Engineering 45 Students Who Agreed Lecture Classes are Superior to Group Discussion Classes (Post-Test)

	Strongly Agree		Agree		Disagree	
	(N)	%	(N)	%	(N)	%
Fall	(30)	35	(45)	52	(12)	14
Winter	(18)	25	(44)	61	(10)	14
Spring	(19)	30	(37)	54	(12)	18

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TABLE 8

Percentage of Engineering 45 Students who Agreed Emphasis Should be Placed on Independent Study (Post-Test)

	Strongly Agree		Agree		Disagree	
	(N)	%	(N)	%	(N)	%
Fall	(7)	8	(51)	58	(30)	34
Winter	(6)	8	(37)	51	(30)	41
Spring	(7)	10	(44)	64	(18)	26

TABLE 9

Extent Engineering 45 Students Felt Their Course Encouraged Them to Think Independently, in Percent (Post-Test)

Course unit and Quarter	(N)	Greatly 1	2	3	Did not 4
Mechanical					
Fall	(88)	23	34	26	17
Winter	(71)	27	32	15	25
Spring	(68)	31	34	25	10
Electrical					
Fall	(88)	11	31	24	34
Winter	(71)	6	21	32	41
Spring	(67)	8	21	42	30
Concrete					
Fall	(88)	11	19	38	32
Winter	(71)	6	18	44	32
Spring	(68)	6	25	37	32
Entire Course					
Fall	(88)	22	48	23	8
Winter	(71)	24	42	23	11
Spring	(68)	29	41	21	9

TABLE 10

Rating of Attention in Class by Engineering
45 Students, in Percent (Post-Test)

Course unit and Quarter	(N)	Excellent 1	2	3	Poor 4
Mechanical					
Fall	(87)	6	25	40	29
Winter	(73)	8	33	32	27
Spring	(69)	10	29	39	22
Electrical					
Fall	(88)	13	28	36	23
Winter	(73)	7	29	33	32
Spring	(69)	10	28	41	22
Concrete					
Fall	(87)	9	31	40	20
Winter	(73)	22	40	21	18
Spring	(69)	17	30	38	15
Entire Course					
Fall	(88)	5	31	48	17
Winter	(72)	8	38	33	21
Spring	(69)	15	29	39	17

TABLE 11

Extent Engineering 45 Students Felt Their Course Encouraged Critical Thinking in the Solution of Problems, in Percent (Post-Test)

Course unit and Quarter	(N)	Greatly 1	2	3	Did not 4
Mechanical					
Fall	(87)	30	33	26	10
Winter	(73)	27	30	29	14
Spring	(68)	31	41	13	15
Electrical					
Fall	(87)	41	28	22	9
Winter	(73)	29	33	23	15
Spring	(68)	28	41	15	16
Concrete					
Fall	(87)	32	36	26	6
Winter	(73)	26	32	27	15
Spring	(67)	24	48	19	9
Entire Course					
Fall	(86)	30	40	23	7
Winter	(73)	25	40	22	14
Spring	(67)	25	48	19	8

TABLE 12

Percentage of Engineering 45 Students Reporting
How Stimulating They Found Their Course (Post-Test)

Course unit and Quarter	(N)	Very 1	2	3	Not 4
Mechanical*					
Fall	(89)	20	28	35	17
Winter	(72)	28	29	15	28
Spring	(70)	37	37	21	4
Electrical*					
Fall	(88)	10	27	35	27
Winter	(72)	4	19	31	46
Spring	(70)	7	24	23	44
Concrete*					
Fall	(88)	6	42	24	28
Winter	(72)	33	29	21	17
Spring	(70)	19	57	17	7
Entire Course*					
Fall	(86)	1	19	54	27
Winter	(70)	1	27	44	27
Spring	(70)	6	41	40	13

*Chi-square indicates significant differences, with minimum criterion = $p \leq .05$.

TABLE 13

Value Engineering 45 Students Placed on Their Course Compared with Other College of Engineering Courses, in Percent (Post-Test)

Course unit and Quarter	(N)	Exceptional 1	2	3	Little 4
Mechanical*					
Fall	(88)	10	24	28	38
Winter	(72)	13	32	31	25
Spring	(67)	16	36	37	10
Electrical*					
Fall	(88)	22	31	24	24
Winter	(72)	10	31	31	29
Spring	(66)	26	24	41	9
Concrete*					
Fall	(87)	9	39	23	29
Winter	(72)	14	38	32	18
Spring	(66)	23	29	36	12
Entire Course*					
Fall	(88)	7	32	41	21
Winter	(71)	11	32	37	20
Spring	(67)	15	36	43	6

*Chi-square indicates significant differences, with minimum criterion = $p<.05$.

TABLE 14

Summary of Spring Quarter Students' Evaluation
of Their Media Labortory Experience

Set	Slides helpful		Slides easy to understand		Overall impression favorable		Related text easy to under-stand		In booth alone		Student discussion helpful		Slides viewed twice or more	
	(N)	%	(N)	%	(N)	%	(N)	%	(N)	%	(N)	%	(N)	%
Crystal Structure	(62)	100	(61)	98	(62)	97	(60)	95	(62)	51	(28)	89	(62)	42
Planer Technology	(19)	95	(19)	100	(19)	95	(18)	95	(19)	90	(2)	100	(18)	44
Transistor Fundamentals	(25)	96	(25)	92	(26)	96	(25)	84	(27)	86	(3)	67	(26)	38

TABLE 15

Propertion of Total Engineering 45 Students in each Intellectual Disposition Category

	I	II	III	IV	Total
(Number)	(12)	(64)	(127)	(19)	(222)
Percent	5	29	57	9	100

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TABLE 16

Total Engineering 45 Students' Media-related Final Examination Scores on Item 8e by Intellectual Disposition Category

Intellectual Disposition Category	(N)	Mean	S. D.
I	(12)	1.333	0.89
II	(64)	1.063	0.79
III	(127)	0.961	0.79
IV	(19)	0.579	0.69
F ratio	2.69		
p	.05		

TABLE 17

Total Engineering 45 Students' Scores on College Environment Scales Scored "Greatly True for Me" by Intellectual Disposition Category

Intellectual Disposition Category	Environment scale		
	Awareness	Scholarship	Properity
I (N=12)			
Mean	3.667	3.750	1.667
(S.D.)	(0.492)	(0.622)	(0.985)
II (N=64)			
Mean	3.453	3.484	1.859
(S.D.)	(0.942)	(0.926)	(1.180)
III (N=127)			
Mean	3.197	3.346	2.220
(S.D.)	(1.047)	(1.019)	(1.119)
IV (N=19)			
Mean	2.474	2.789	2.789
(S.D.)	(0.964)	(1.316)	(1.316)
F ratio	5.61	2.98	4.19
p	.01	.05	.01

TABLE 18

Total Engineering 45 Students' Scores on Educational Benefits Indices by Intellectual Disposition Category

Intellectual Disposition Category	Liberal Education		Personal and Social Development	
	Mean*	S. D.	Mean*	S. D.
I (N=12)	10.7	2.6	7.3	2.4
II (N=64)	12.0	2.6	7.5	2.2
III (N=127)	13.3	2.8	8.2	2.4
IV (N=19)	14.5	2.7	8.7	2.5
F ratio	8.10		2.42	
p	.01		N.S.	

*For each index the lowest score indicates the greatest importance placed on the item; the highest socre, the least importance.

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TABLE 19

Total Engineering 45 Students' Scores on Selected
and Total Items of Changing Society Index (Occuring)
Intellectual Disposition Category

Intellectual Disposition Category	Item Scores							Total score
	Intercity govern-ment	Industrial collab-eration	Inter-national market	Partici-pative politices	Value of self expression	Industrial community resources	Community related production costs	
I (N=12)								
Mean	0.667	0.750	1.000	0.833	0.750	0.417	0.917	19.667
(S.D.)	(0.492)	(0.452)	(0.0)	(0.389)	(0.452)	(0.515)	(0.289)	(3.420)
II (N=64)								
Mean	0.734	0.563	0.906	0.609	0.547	0.141	0.906	18.469
(S.D.)	(0.445)	(0.500)	(0.294)	(0.492)	(0.502)	(0.350)	(0.294)	(4.364)
III (N=127)								
Mean	0.433	0.433	0.811	0.504	0.417	0.173	0.811	16.449
(S.D.)	(0.497)	(0.497)	(0.393)	(0.502)	(0.495)	(0.380)	(0.393)	(3.646)
IV (N=19)								
Mean	0.421	0.263	0.684	0.474	0.526	0.105	0.684	16.316
(S.D.)	(0.507)	(0.452)	(0.478)	(0.513)	(0.513)	(0.315)	(0.478)	(4.001)
F ratio	6.1[illegible]	3.40	2.89	2.13	2.30	2.05	2.21	5.7[illegible]
p	.01	.05	.05	N.S.	N.S.	N.S.	N.S.	.01

TABLE 20

Total Engineering 45 Students' Scores on Selected and Total Items of Changing Society Index (Desireable) by Intellectual Disposition Category

Intellectual Disposition Category	Item Scores							Total score
	Partici-pative politices	Value of self Expression	Value of interde-pendence	Influence of sci-entists & profes-sionals	Intercity govern-ment	Industrial collab-eration	Devaluation of individ-ual success	
I (N=12) Mean (S.D.)	1.000 (0.0)	1.000 (0.0)	0.500 (0.522)	0.917 (0.289)	0.833 (0.389)	0.0 (0.0)	0.417 (0.515)	8.583 (2.065)
II (N=64) Mean (S.D.)	0.813 (0.393)	0.672 (0.473)	0.453 (0.502)	0.766 (0.427)	0.563 (0.500)	0.359 (0.484)	0.219 (0.417)	7.391 (2.592)
III (N=127) Mean (S.D.)	0.606 (0.491)	0.528 (0.501)	0.260 (0.440)	0.559 (0.498)	0.409 (0.494)	0.181 (0.387)	0.142 (0.350)	5.945 (2.586)
IV (N=19) Mean (S.D.)	0.632 (0.496)	0.211 (0.419)	0.474 (0.513)	0.737 (0.452)	0.316 (0.478)	0.263 (0.452)	0.211 (0.419)	5.895 (2.183)
F ratio	5.01	8.27	3.44	4.45	4.24	3.96	2.16	7.74
p	.01	.01	.05	.01	.01	.01	N.S.	.01

ENGINEERING 45
Final Examination
Part 1

....

2. a. Make sketches showing the close-packed planes in both fcc and hex c.p. crystal structures.

   b. How many differently oriented sets of close-packed planes are there in each of the two structures?

   fcc ______________________________

   hcp ______________________________

4. a. How much pearlite would there be in a 0.40% C steel that had been cooled slowly from the austenite temperature range to room temperature?

   b. How much martensite would there be in 0.40% C steel that had been quenched rapidly in cold water from the austenite range to room temperature? Assume that the piece being quenched was small, e.g. a 1/4 inch diameter cylinder.

5. The melting point of lead is 327° C. The melting point of antimony is 630° C. Lead-antimony form a eutectic at 250° C and at 17.5% Sb. The solubility of Sb in solid Pb at the eutectic temperature is 5.3%. Sketch cooling curves (from liquid state to room temperature) for the following metals and alloys:

   a. 100% Pb
   b. 100% Sb
   c. 95% Pb - 5% Sb
   d. 90% Pb - 10% Sb
   e. 82.5% Pb - 17.5% Sb
   f. 77% Pb - 23% Sb

   The cooling curves should be sketched neatly and unambiously, and important temperatures should be specified on each.

7. What kind of bonds hold the atoms together in each of the following:

   ....

   b. Diamond ______________________________

   ....

8. a. Define the term "a ceramic material".

....

e. Why is glass amorphous? Can a glass crystallized? If so, how?

9. b. Why are the crystal structures of ceramics more complex than those of metals?

10. a. (6) Compare and contrast the two classifications of polymerizations

Condensation (also known as step) polymerization

Addition (also known as chain) polymerization

b. (2) Which kind of polymerization is characterized by the need for initiation and has rapid propagation to yield a high molecular weight polymer?

c. (3) Which of the following three characteristics are favorable to the formation of polymer crystals (underline your choice):

A linear polymer or a network polymer?

An atactic polymer or an isotactic polymer?

A polymer showing the trans arrangement (where the unsaturated positions are on opposite sides of the chain) or the cis (same side)?

d. (3) Define the glass transition temperature for a polymer.

11. a. What are the differences between the following two models of polymer crystals: The fringed micelle model and the chain-folded model.

b. What are the characteristics of a thermoplastic? What kind of bonding exists between its polymer molecules?

c. What are the characteristics of a thermosetting plastic? What kind of bonding exists between its polymer molecules?

12. In a tree:

a. Moisture and minerals from the soil move up from the roots through the ______________________________.

b. The cambium layer is the zone where ______________________________
____.

c. Annual growth rings are made up of two kinds of wood: ______________ and ______________.

d. Tracheids are long slender cells that make up 90% of ____________.

e. Which kind of wood is called porous? ____________________________.

f. The major chemical constituent of wood is ______________________.

g. The binder between the cells is ______________________________.

h. The rate of growth can be determined by ________________________
____.

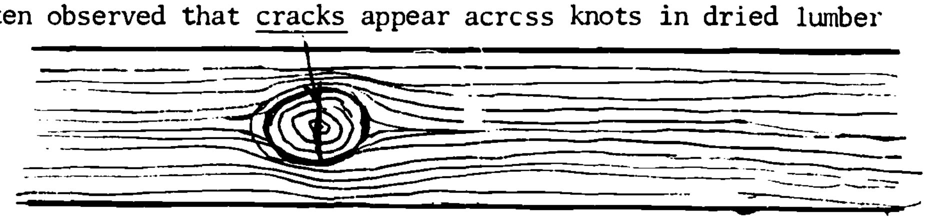
13. a. What steps must be taken to prevent the "decay" of wood?

b. Cross out the incorrect word:

The ultimate strength of wood is (sensitive/insensitive) to free water, and it is (sensitive/insensitive) to bound water. Explain your answers.

c. How does the drying shrinkage of wood vary in the longitudinal, radial and tangential directions?

d. It is often observed that cracks appear across knots in dried lumber as shown:



Use your knowledge of the shrinkage of wood to explain this cracking.

14. a. How are capillary pores formed in portland cement paste?

b. Why is water sprayed on concrete for approximately one to seven days after it has been placed?

c. Sketch the microstructure of a completely hydrated portland cement paste that has a gel space ratio of 1.0.

d. Why would the compressive strength of cement paste with gel space ratio of 0.8 be different from the cement paste with a gel space ratio of 1.0?

16. We have seen that two back-to-back p-n junctions in a single crystal of silicon can give us transistor action. Can two p-n junctions in separate pieces of silicon also produce transistor action? Explain.

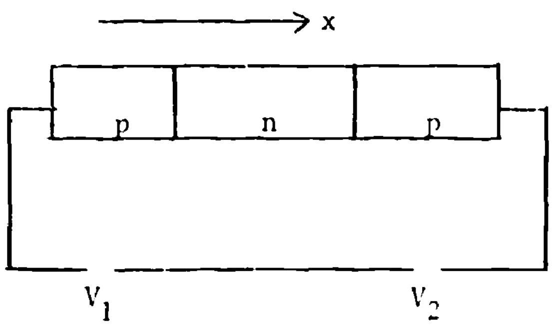
17. Outline the steps necessary for the construction of a p-n junction diode using a planar process (i.e., the same process used for integrated-circuit fabrication). Start with a clean, polished semiconductor wafer (p-type silicon) and assume that the photographic masks have been previously prepared. The finished diode should be ready to be soldered into a discrete (non-integrated circuit).

18. In a Si pnp transistor biased for amplification, the excess hole concentration p_1 in the base region can be described by the relation

$$p_1 = p_0 \left(e^{V_1/V_T} - 1\right)\left(1 - \frac{x}{W}\right)$$

if the base is very narrow. V_1 is the bias across the emitter-base junction, V_T is a voltage related to the thermal energy and equals 0.026V at 300°K, and P_o is the thermal equilibrium hole density in the base ($p_o = 10^{11}/m^3$). Note that almost all of the applied voltage is dropped across the p-n junctions.

If the doping in the 10^{-6} m-wide base is $10^{21}/m^3$ and 0.52 V is applied between emitter and base, find the current in the base region. The cross-sectional area of the transistor is $10^{-7} m^2$. In which direction does the current flow? Indicate the polarity of V_1 and V_2 for this type of the operation on the diagram below.



19. We have seen that light incident on a laser can be amplified by stimulated emission. The expression we derived for the attenuation of incident light in a normal medium still holds, but the absorption coefficient becomes negative. Assuming that a fraction R of the light is reflected at each end of a laser length L, find the magnitude of the "absorption coefficient" at the threshold of the laser action (i.e., the intensity of the light must not be attenuated in one complete pass through the system).

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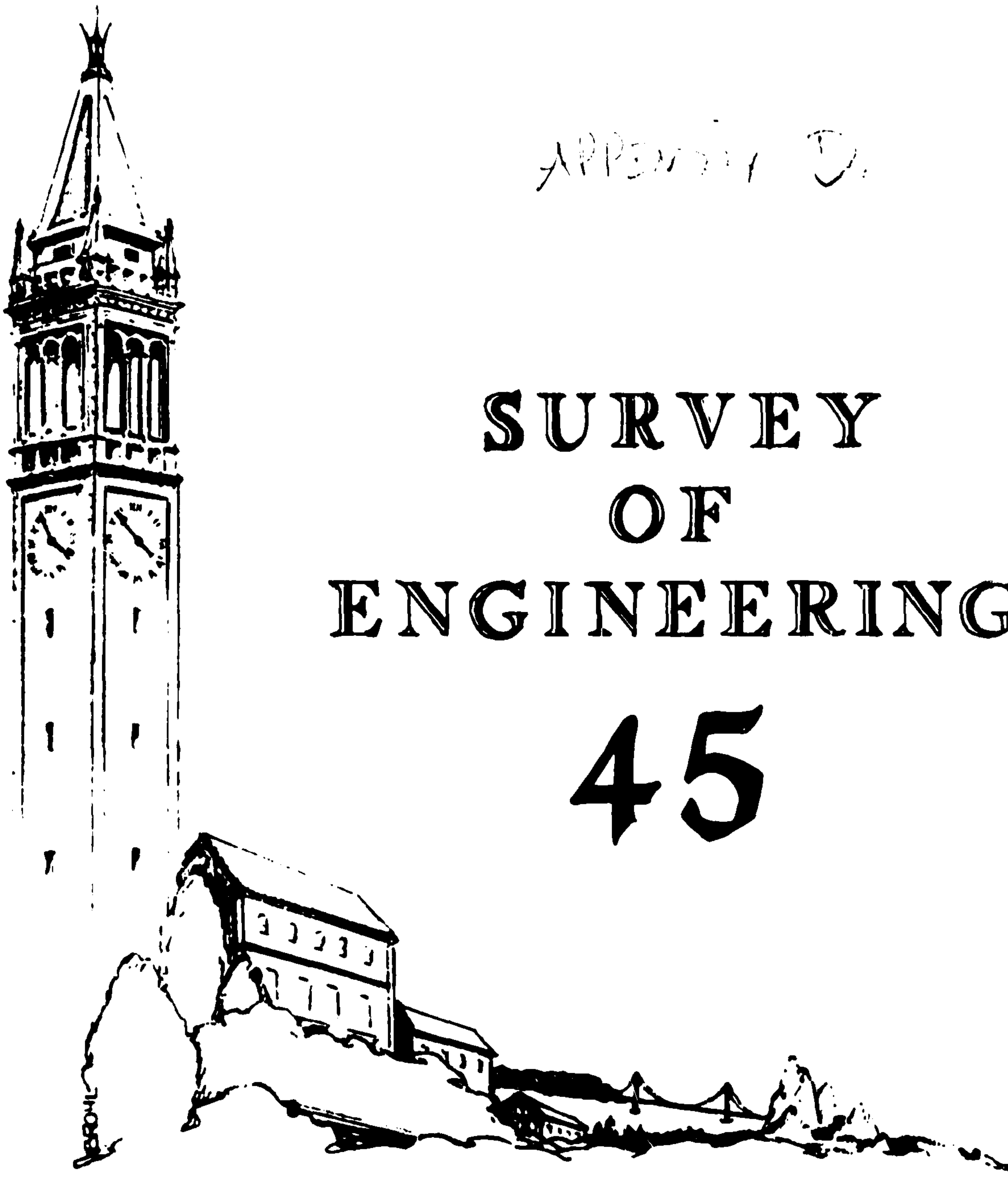
APPENDIX D.



SURVEY OF ENGINEERING

45

COLLEGE OF ENGINEERING

UNIVERSITY OF CALIFORNIA, Berkeley

ERIC

ID Number__________
(71-76)

SURVEY OF ENGINEERING 45

In the items to follow you are asked to evaluate your experiences, interests, and goals in college. This is an important source of information in any assessment of an instructional program. Again, you are reminded that all information is confidential, that no individual's responses will be reviewed by the faculty, and that your name is requested only so that all information obtained from you may be combined. Nevertheless, you are free to skip items you prefer not to answer.

1. What is your name?____________________

2. Your sex?
(1) 1___ Male
2___ Female

3. Your age?
(2) 1___ 17-18
2___ 19-20
3___ 21-22
4___ 23-24
5___ 25 or over

4. How many units have you had...

In the College of Engineering?
(3) 0___ 30 or fewer
1___ 31-35
2___ 36-40
3___ 41-45
4___ 46-50
5___ 51-55
6___ more than 55 units

In the College of Letters & Science?
(4) 0___ 4 or fewer
1___ 5-8
2___ 9-14
3___ 15-21
4___ 22-28
5___ more than 28 units

EDUCATIONAL EXPERIENCE

5. From what kind of high school did you graduate? (Check one)

(5) 1___ Public
2___ Catholic
3___ Other church related
4___ Private (independent)

6. About how many students were in your high school graduating class? (Check one)

(6) 1___ Fewer than 100
2___ Between 100 and 500
3___ More than 500

7. Approximately what was your average grade in high school? What is it so far in college? Check one for both high school and college.

(7) High School:

1___ D, C-
2___ C
3___ C+
4___ B
5___ B+
6___ A, A+

(8) College:
1___ D, C-
2___ C
3___ C+
4___ B
5___ B+
6___ A, A+

8. When did you first decide that you wanted to go to college?

(9) 1___ After high school
2___ Last year in high school
3___ Junior year in high school
4___ Sophomore year in high school
5___ Freshman year in high school
6___ While in grade school
7___ Don't remember

9. Indicate the relative frequency with which you engaged in the following in an <u>average month</u> during your last term, by circling appropriate number.

In an average month, I. . .	Not at all	Once or twice	Three or more times	
Spent an hour or more reading course-related but unrequired material.	1	2	3	(10)
Went to a doctor's office or hospital for treatment.	1	2	3	(11)
Studied on a Saturday or Sunday morning.	1	2	3	(12)
Read an assignment without understanding it.	1	2	3	
Got very interested in a course-related lecture or discussion.	1	2	3	
Missed a meal because of study.	1	2	3	
Presented a new idea or plan of action in a lab or class discussion.	1	2	3	
Got left behind in a course-related lecture or discussion section.	1	2	3	(17)
Started a lively discussion among student friends.	1	2	3	
Got discouraged and talked it over with a friend or instructor.	1	2	3	
Turned in an assignment late.	1	2	3	
Browsed through the library.	1	2	3	
Sat through a class discussion without saying anything.	1	2	3	(22)
Had an interview or session with a counselor, psychologist or psychiatrist. . .	1	2	3	
Socialized with an instructor (over coffee, coke, beer, etc.).	1	2	3	
Had trouble concentrating while trying to study.	1	2	3	
Wrote a paper or report with which I was very pleased.	1	2	3	
Had fun with some friends when I still had work to do.	1	2	3	(27)
Missed class because of sickness.	1	2	3	(28)

10. As well as you can recall, about how much did you participate in various activities when you were in high school? How much so far in college? For each type of activity listed below, please circle the amount of your participation in it.

	IN HIGH SCHOOL					IN COLLEGE				
	Much	Some	None	None available		Much	Some	None	None available	
(29)	1	2	3	4	Varsity sports	1	2	3	4	(45)
	1	2	3	4	Other sports	1	2	3	4	
					Publications:					
	1	2	3	4	School paper	1	2	3	4	
	1	2	3	4	Creative writing	1	2	3	4	
	1	2	3	4	Dramatics	1	2	3	4	
(34)	1	2	3	4	Debate	1	2	3	4	(50)
	1	2	3	4	Arts and crafts	1	2	3	4	
	1	2	3	4	Music: chorus, band, etc.	1	2	3	4	
	1	2	3	4	Student government	1	2	3	4	
	1	2	3	4	Religious groups	1	2	3	4	
(39)	1	2	3	4	Social service groups	1	2	3	4	(55)
					Social groups:					
	1	2	3	4	Fraternities, etc.	1	2	3	4	
	1	2	3	4	Political groups	1	2	3	4	
	1	2	3	4	Science clubs or projects	1	2	3	4	
	1	2	3	4	Other academic groups, honoraries, clubs related to your school work	1	2	3	4	
(44)	1	2	3	4	Foreign student exchange	1	2	3	4	(60)

11. To what extent are you encouraged by your instructors to:

	Considerably	Somewhat	Little	Not at all	
Select your own subject in writing papers, reports or projects?	1	2	3	4	(61)
Question the teacher's point view in class?	1	2	3	4	(62)
Do outside reading?	1	2	3	4	(63)

12. To what extent do the following create difficulties for you in college? (Please circle your response)

	Very much	Quite a lot	Some	Very little	
Work outside school.	1	2	3	4	(64)
Time spent commuting	1	2	3	4	
Learning how to study.	1	2	3	4	
Methods of instruction	1	2	3	4	
Being on my own too much	1	2	3	4	
Keeping up with high academic standards	1	2	3	4	(69)
Personal problems	1	2	3	4	(70)
					(71-79)
					(80)1
Poor study facilities.	1	2	3	4	(1)
Extracurricular and social activities	1	2	3	4	
Writing papers in my own field .	1	2	3	4	(3)
Writing papers outside my own field.	1	2	3	4	
Not enough interest.	1	2	3	4	
Not enough challenge	1	2	3	4	
Insufficient reading speed . . .	1	2	3	4	

Other; specify: ______________________________ (8)

13. How important are the following to your motivation to study: (Please circle your response)

	Very important	Fairly important	Unimportant	
Grades	1	2	3	(9)
To please my parents	1	2	3	
To do my best	1	2	3	
To keep my scholarship	1	2	3	
Interest in subject	1	2	3	
Desire to graduate	1	2	3	(14)
Career plans	1	2	3	
Faculty pressure	1	2	3	
To get into graduate school. .	1	2	3	
Sheer interest in learning . .	1	2	3	(18)

14. In general, how important is a college education for a man, for a woman, and for you personally? (Please check one answer for each column.)

For a man	For a woman	For you	
(19) 1___	(20) 1___	(21) 1___	Very important
2___	2___	2___	Somewhat important
3___	3___	3___	Unimportant

15. How likely do you feel it will be that you graduate from college?

(22) 1___Very likely
2___Fairly likely
3___Fairly unlikely

16. What is the highest level of education you wish to obtain?

(23) 1___Bachelor's degree
2___Some graduate work
3___Masters degree; Field:______________ (24)
4___Doctorate degree; Field:______________ (25)
5___Advanced professional: Law
6___Advanced professional: Medicine
7___Advanced professional: Other; Field:________ (26)

17. How sure are you of this?

(27) 1___Very sure
2___Fairly sure
3___Unsure

ERIC

CURRICULUM INTERESTS

18. When you made your choice of engineering as a major, from how many possible fields did you choose: i.e., as well as you can remember, how many fields were you interested in when you made your present choice, however tentative?

(28) 1___One - the only field I have ever really been interested in
2___Two
3___Three
4___Four or more

19. What is your particular major field of engineering?

(29) 1___Electrical
2___Mechanical
3___Civil
4___Other (Please specify:_______________________________)
5___Have not yet decided

20. How sure are you of this?

(30) 1___Very sure
2___Fairly sure
3___Unsure, tentative

21. When did you decide on your college major?

(31) 1___6th grade or earlier
2___7th through 9th grade
3___10th through 12th grade
4___After high school but before college
5___After entering college
6___Have not yet decided

22. What were the main reasons for your choice of this major? (Check all those that apply)

(32) ___Long-term interest
___Made good grades in related subjects during high school
___It appeared to have the least overall pressure (difficulty or amount of work; competition)
___Parents' wish or advice
___High school faculty encouraged me
(37) ___Prestige of occupation toward which it leads
___Leads to work with people
___Freedom of course selection in that department
___I had friends majoring in it who influenced me
___Quality of faculty or their approach
(42) ___Leads to monetary rewards
___Gives good well-rounded education
(Please comment)______________________________
___Opportunity for significant accomplishment in the area
(Please comment)______________________________
___Chance, no particular reason
(46) ___Other; Specify:______________________________

23. Please indicate the extent of understanding you feel you have about each of the following:

	A great deal of under standing	Some under-standing	Little or no under-standing	
The nature and requirements of my specific major in engineering	1	2	3	(47)
The subject matter of courses I have already completed toward my major	1	2	3	(48)
The nature of the various occupations my major is preparing me for	1	2	3	(49)
The nature of the requirements of the various majors within the school of engineering	1	2	3	(50)
The nature of the various occupations available to engineers generally	1	2	3	(51)

24. Several courses follow in which large numbers of students tend to enroll. Under each course are listed a variety of topics, information, and tasks to be accomplished.

Assume that you are enrolled in these courses and therefore must learn about each of the items listed below.

The items are listed in groups of three. For each group mark a . . .

"1" by the item that you would like most;
"2" by the item in which you would have an intermediate interest; and a
"3" by the item that would interest you least.

Examples:

Business and Economics

A___

1. _2_ The functions of the Securities and Exchange Commission
2. _3_ Factors operating to diminish the size of the U.S. gold reserve.
3. _1_ When an "easy money" policy may be unsound public policy

B___

4. _2_ The names of the components of the "Gross National Product."
5. _1_ The meaning of an "odd lot" in stock purchases.
6. _3_ The purpose underlying agricultural price supports.

In Group A the respondent indicates that he is most interested in item 3 ("When an 'easy money' policy may be unsound public policy"); least interested in item 2 ("Factors operating to diminish the size of the U.S. gold reserve"); and has an intermediate interest in item 1 (The functions of the Securities and Exchange Commission."). Of the three items in Group B he is most interested in 5, least interested in 6, and has an intermediate interest in 4.

Be sure to rank each item in each group accordingly, and do not assign the same rank to two items in a single group.

Geography

(52) A___

___The factors responsible for westward population migration in the U.S.
___The names of the capitals of the European countries.
___The names and locations of the 10 largest rivers in the world.

Q. 24 continued
(1 = most, 2 = intermediate, 3 = least)

(53) B___

___The average annual per capita consumption of petroleum products in the U.S.
___The definitions of Loess, mesas, drumlins, lithosphere, playas, and biosphere.
___Requisities for artesian well systems.

(54) C___

___How artesian wells are formed.
___Forecasts about the weather to be expected in New York City during the next 48 hours from examination of a weather map.
___The chemical composition of lava.

(55) D___

___The meaning of "cold", "warm," "occluded," and "cyclonic" fronts.
___The five major world producers (in order of importance) of iron, lead, [illegible] and copper.
___The role of seaports in national economy.

(56) E___

___The factors considered by geologists in attempting to locate oil deposits.
___Statistics on the average family size for each socioeconomic subgroup.
___Population shifts in the United States during the past 50 years.

(57)

Natural Science

(58) A___

___The explanation for the fact that it is sometimes difficult to recognize voices on the telephone.
___The distances from earth to the other planets in our galaxy.
___The critical velocity required to escape the earth's gravitational pull.

(59) B___

___The names of the elements included within the "halide" group.
___Statement of Newton's third law of motion.
___The significance of pH of 6.

Q. 24 continued
(1 = most, 2 = intermediate, 3 = least)

(60) C___

___Formula for converting centigrade temperature readings to fahrenheit readings.
___The difference in chemical structure between H_2O (water) and H_2O_2 (hydrogen peroxide).
___The distinction between "anode" and "cathode."

(61) D___

___Chemical factors associated with transmitting neural impulses.
___Why thrust is generated by a jet engine.
___The chemical structure of penicillin.

(62) E___

___The relative conductivity of certain substances (e.g., iron, copper, zinc, wood).
___The meaning of "specific gravity."
___The effect of increased pressure upon the boiling point of a liquid.

(63)

English

(64) A___

___Write a report on the novel entitled 1984.
___The names of Shakespeare's comedies.
___The reason why Hedda Gabler (in Ibsen's Hedda Gabler) kills herself.

(65) B___

___The names of 10 contemporary authors and their most important works.
___Write a biographical sketch based upon library research of any author (no longer living) of your choice.
___The effects of 19th century American history upon the American literature of the period.

(66) C___

___The elements in a play that lead to its classification as a "tragedy."
___The correct spelling for the word meaning "to pay" (i.e., is it "renumerate" or "remunerate").
___Write a theme about the most interesting person you have ever met.

Q. 24 continued
(1 = most, 2 = intermediate, 3 = least)

(67) D___

___The dates and major work of well-known poets like Whitman, Longfellow, Wordsworth, etc.
___The role of the playwright in contemporary society.
___The structure (i.e., number of lines, rhyming schemes, etc.) of sonnets.

(68) E___

___The influence of the Romantic poets on modern poetry.
___The times the different literary periods began.
___The essential difference between an epic and a ballad.

(69-70)

(71-79)

(80)2

(1-2)

25. Below are a number of benefits people think apply to various undergraduate college majors, examples of which are also listed. Please check for each major the benefit you think applicable.

MAJOR					
Bus. Adm.	Pol. Sci.	Bio.	Eng. Lit.	Eng'eer	BENEFIT
___	___	___	___	___	0 Leads to secure job
___	___	___	___	___	1 Constitutes an important body of knowledge
___	___	___	___	___	2 Entails original thinking
___	___	___	___	___	3 Contributes to understanding of life
___	___	___	___	___	4 Stimulated critical thinking
(7)	(17)	(27)	(37)	(47)	
___	___	___	___	___	5 Represents a great interest to me
___	___	___	___	___	6 Leads to responsible job
___	___	___	___	___	7 Leads to well-paying job
___	___	___	___	___	8 Offers chance to contribute to society
___	___	___	___	___	9 Offers creative outlets
(12)	(22)	(32)	(42)	(52)	

26. Now, please circle above the one benefit you think most important, regardless of specific major.
(53)

VIEWS ON EDUCATION

27. In thinking about your undergraduate education at U.C., how important do you consider each of the following benefits of a college education? For each of the items listed below, circle the number in the:

VI column if it is very important to you, in the
SI column if it is somewhat important, in the
U column if it is unimportant, or in the
VU column if it is very unimportant to you.

	VI	SI	U	VU	
Vocational training--skills and techniques directly applicable to a job.	1	2	3	4	(54)
Background and specialization for further education in some professional, scientific or scholarly field.	1	2	3	4	
Broadened literary acquaintance and appreciation.	1	2	3	4	
Awareness of different philosophies, cultures, and ways of life.	1	2	3	4	
Social development--experience and skill in relating to other people.	1	2	3	4	
Personal development--understanding one's abilities and limitations, interests, and standards of behavior.	1	2	3	4	(59)
Critical thinking--logic, inference, nature and limitations of knowledge.	1	2	3	4	
Aesthetic sensitivity--appreciation and enjoyment of art, music, drama.	1	2	3	4	
Writing and speaking--clear, correct, effective communication.	1	2	3	4	
Science and technology--understanding and appreciation.	1	2	3	4	
Citizenship--understanding and interest in the style and quality of civic and political life.	1	2	3	4	(64)

Q. 27 continued

	VI	SI	U	VU	
Appreciation of individuality and independence of thought and action.	1	2	3	4	(65)
Development of friendships and loyalties of lasting value.	1	2	3	4	
Vocabulary, terminology, and facts in various fields of knowledge.	1	2	3	4	
Appreciation of religion--moral and ethical standards.	1	2	3	4	
Tolerance and understanding of other people and their values.	1	2	3	4	
Bases for improved social and economic status.	1	2	3	4	(70)

(71-79)

(80)3

ERIC

28. Please indicate how you feel about each of the following statements. For each statement listed below, circle the number in the:

SA column, if you <u>strongly agree</u>, in the
A column, if you generally <u>agree</u>, in the
D column, if you generally <u>disagree</u>, or in the
SD column, if you <u>strongly disagree</u>.

	SA	A	D	SD	
An authoritative textbook is superior to reliance upon original readings.	1	2	3	4	(1)
It is a good learning experience for the student to be left with ambiguous or conflicting opinions so that he must arrive at the solution to a given problem on his own.	1	2	3	4	
Self-responsibility is best taught students by establishing definite rules of behavior (e.g., visitation privileges, study hours, and style of dress).	1	2	3	4	
I prefer to follow course work which emphasizes retention of facts.	1	2	3	4	
Students should participate significantly in the organization of courses and development of academic policy.	1	2	3	4	(5)
Students should be given great freedom in choosing their courses of study.	1	2	3	4	
I learn best when course presentation includes visual aids such as plates, models, and slides.	1	2	3	4	
Class assignments which depend upon the student's own initiative are preferable to definite, structural assignments.	1	2	3	4	
It is a good idea for faculty to mix informally with students by inviting them to their homes or by joining them in student lounges or snack bars.	1	2	3	4	
Students should be encouraged to seek their own answers to their questions.	1	2	3	4	(10)
Lecture classes are superior to group discussion classes.	1	2	3	4	
Emphasis should be placed on independent study.	1	2	3	4	(12)

Q. 28 continued

	SA	A	D	SD	
I learn as well from hearing a lecture as from reading the same material in a book.	1	2	3	4	(13)
A traditional college is preferable to one which emphasizes a lot of experimental courses.	1	2	3	4	
It is a good idea to indicate the relationship among courses instead of treating each course separately.	1	2	3	4	(15)
Movies are very helpful in understanding course materials.	1	2	3	4	
I am quite concerned about how well I am doing in college compared with my classmates.	1	2	3	4	
I often find myself bored in class.	1	2	3	4	
In most courses I have had, students are treated more like apprentices than colleagues.	1	2	3	4	
I have found most of my instructors to be quite stimulating intellectually.	1	2	3	4	(20)
Most faculty members in my department are really interested in their students.	1	2	3	4	
I have felt challenged to my full capacity by the requirements I have experienced at the University.	1	2	3	4	
Most existing rules and regulations regarding student behavior are sensible and necessary	1	2	3	4	
I am quite satisfied with my experience at the University	1	2	3	4	
I have some doubts about whether engineering is really the right field for me.	1	2	3	4	(25)
I am not satisfied unless I have done my best in my course work.	1	2	3	4	
I am generally very satisfied with my department at the University.	1	2	3	4	(27)

PERSONAL INFORMATION

29. We all have different preferences and personal characteristics. We would like to know more about the relationship of different choices and traits to important college and subsequent career experiences. On the left please check all the items below that you generally find to your liking. On the right, please check all the adjectives that you think are generally descriptive of you. (Please check all items that apply.)

I generally like:

(28)___Unquestioning obedience
___Strict law enforcement
___The tried and true
___Determination and ambition
___Strong family ties
(33)___Unwavering patriotism
___Perfect balance in composition
___Novel experiences
___Predictable outcomes to problems
___Original work
(38)___A set schedule of activities
___A proper place for everything
___The one right answer to questions
___Friends without complex problems
___Straight-forward reasoning
(43)___Dealing with new or strange ideas
___The perfectly completed object
___Quick unhesitating decisions
___Original research work
___To draw my own conclusions
(48)___Solving long, complex problems
___Critical consideration of theories
___Science and mathematics
___Contemplating the future of society
___Men of ideas
___Discovering how things work
___Scientific displays
(55)___Detecting faulty reasoning

I generally am:

(56)___Well-organized
___Practical
___Individualistic
___Questioning
___Predictable
(61)___Open-minded
___Introspective
___Experimental
___Creative
___Undistracted
(66)___Analytical
___Critical-minded
___Scientific
___Socially-minded
(70)___Contemplative

(71-79)

(80)4

(1)___Dutiful
___Determined
___Conventional
___Unrestrained
(5)___Adaptable
___Permissive
___Worried
___Happy
___Calm
(10)___Self-confident
___Nervous
___Anxious
(13)___Restless

30. What is your father's specific occupation? State exactly what he does and the kind of place where he works, e.g., "sells clothes in a department store," "does chemical research for an oil company," etc. If your father is retired, deceased, or unemployed describe his last occupation. If you live(d) with your stepfather answer for him rather than your father.

____

____

____

31. Please classify your father's and mother's occupations by checking the category on the following list in which each seems to fit best. Please classify your own choice of occupation.

		Father (14-15)	Mother (16-17)	My Choice (18-19)
Professional I (requiring graduate degree, usually at the doctoral level, and a high level of professional responsibility).	10	____	____	____
Professional II (requiring only a baccalaureate degree or master's degree but requiring a certain amount of professional skill).	20	____	____	____
Semi-professional or technical (such as Programmer, Nurse, Lab Technician).	30	____	____	____
Managerial or executive.	40	____	____	____
Public official or supervisor.	50	____	____	____
Small business partner or owner.	60	____	____	____
Sales or clerical.	70	____	____	____
Skilled worker, farm owner, manager, foreman.	80	____	____	____
Semi-skilled worker, laborer, farm worker	90	____	____	____
Housewife	01	____	____	____
Unemployed	02	____	____	____
Unknown	03	____	____	____

________ (20)

32. In thinking about your future occupations, what is your chief area of interest? (Check one.)

(21) 0___Undecided
1___Manufacturing
2___Design
3___Management
4___Sales
5___Research and development
6___Teaching
7___Other (Specify:________________________.)

33. In what kind of organization do you wish to work? (Check one.)

(22) 0___Undecided
1___Self-employed
2___Business or industrial firm
3___Educational agency
4___Government agency
5___Other non-profit agency
6___Other (Specify:________________________.)

34. Which of the following things do you wish to do fairly regularly in your work? (Check as many as apply.)

(23) ___Plan your own work
___Supervise others
___Make policy decisions
___Write reports
___Do original research or writing
(28) ___Keep records
___Instruct others
___Counsel or advise others
___Make speeches or present reports
___Organize operations
___Attend meetings
(34) ___Analyze data

35. Which of the following characteristics do you associate with satisfaction in your future occupations? (Check as many as apply.)

(35) ___Initiative
___Responsibility
___Creativity
___Stability
___Prestige
(40) ___Recognition
___Security
___Opportunity
___Risk
(44) ___Variety

(45) ___Independence
___Regularity
___Stimulation
___Pressure
___Financial Reward
___Pleasant surroundings
(51) ___Interesting associates

36. Have you anything else of importance to add about your views on your education, interests, or goals?

Your education: ______________________________
(52-53)

Your interests: ______________________________
(54-55)

Your goals: ______________________________
(56-57)

Have you any helpful comments to make about this survey? ________
(58-59)

(71-79)

(80)5

Thank you for your cooperation!

UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Mineral Technology

Survey II of Engineering 45

At the beginning of the term you were asked to evaluate your experiences, interests, and goals in college. Now that you have completed this term we are asking you for an additional evaluation of your experiences and for your evaluation of Engineering 45 in particular. This is one major way that we can most efficiently evaluate the quality of the course and its relevance to your interests. Again, you are reminded that all information is confidential, that no individual's responses will be reviewed by the faculty, and that your name is requested only so that all information obtained from you may be combined. Nevertheless, as before, you are free to skip items you prefer not to answer.

Name ______________________________

Section Number ____________________

PERSONAL INFORMATION

1. We all have different preferences and personal characteristics. We would like to know more about the relationship of different choices and traits to important college and subsequent career experiences. On the left please check all the items below that you generally find to your liking. On the right, please check all the adjectives that you think are generally descriptive of you. (Please check all items that apply.)

I generally like:

(1)___Unquestioning obedience
___Strict law enforcement
___The tried and true
___Determination and ambition
___Strong family ties
(6)___Unwavering patriotism
___Perfect balance in composition
___Novel experiences
___Predictable outcomes to problems
___Original work
(11)___A set schedule of activities
___A proper place for everything
___The one right answer to questions
___Friends without complex problems
___Straight-forward reasoning
(16)___Dealing with new or strange ideas
___The perfectly completed object
___Quick unhesitating decisions
___Original research work
___To draw my own conclusions
(21)___Solving long, complex problems
___Critical consideration of theories
___Science and mathematics
___Contemplating the future of society
___Men of ideas
___Discovering how things work
___Scientific displays
(28)___Detecting faulty reasoning

I generally am:

(29)___Well-organized
___Practical
___Individualistic
___Questioning
___Predictable
(34)___Open-minded
___Introspective
___Experimental
___Creative
___Undistracted
(39)___Analytical
___Critical-minded
___Scientific
___Socially-minded
___Contemplative
(44)___Dutiful
___Determined
___Conventional
___Unrestrained
___Adaptable
(49)___Permissive
___Worried
___Happy
___Calm
___Self-confident
___Nervous
___Anxious
(56)___Restless

2. In thinking about your future occupations, what is your chief area of interest? (Check one.)

(57) 0___Undecided
1___Manufacturing
2___Design
3___Management
4___Sales
5___Research and development
6___Teaching
7___Other (Specify _______________)

THE CHANGING SOCIETY

3. There are periods of history when change seems to be more turbulent than others. Often the directions of change seem unclear; and people differ in their judgment about whether particular trends or tendencies are desirable or undesirable. We have listed below a number of statements that describe changes or tendencies which may or may not be occurring in the United States. For each statement indicate first, in the left hand columns, whether you think the change or trend it describes is or is not occurring -- by circling the number if generally True, Don't know, or generally Not true. Then, after some of these statements, and in the right hand columns, you will find space for an additional response. For this response, indicate whether you think the change described would be desirable or undesirable if it in fact occurred or is occurring.

	Occurring: Generally true	Don't know	Generally not true		Desirable: Generally desirable	No opinion	Generally undesirable	
(58)	1	2	3	An increasing proportion of young people are graduating from high school and going to college.	1	2	3	(1)
	1	2	3	The number of people going to school (old and young, full-time and part-time) is, or soon will be, greater than the number of people working at their job.				
	1	2	3	The prolongation of education is increasing the economic dependence of adolescents and young adults on their parents.	1	2	3	(2)
	1	2	3	There is an increasing gap and conflict between generations.				
(62)	1	2	3	The problem of disadvantaged individuals who find themselves in chronic poverty is becoming more serious.				
	1	2	3	Environmental pollution (especially of the air and water) is becoming a critical problem.				
	1	2	3	The rate of consumption of natural resources is threatening to exhaust their supply.				
	1	2	3	Society is becoming so complex and interdependent that it is no longer adequate to try to solve one problem at a time.				
	1	2	3	Long range planning is becoming essential for the health and welfare of large urban areas.				
	1	2	3	A new style of politics, involving broader and more active participation at all levels, is emerging.	1	2	3	(3)
	1	2	3	More people are coming to realize and accept the value of self-expression--for example, through the arts.	1	2	3	(4)
	1	2	3	As our society develops, the capacity for inter-dependence (relating with others) may be valued more highly than the capacity for independence and self-reliance.	1	2	3	(5)
(70)	1	2	3	Less importance is being attached to the value of individual success and achievement than has been traditional in our society.	1	2	3	(6)

(71-79)1

(Question 3 continued)

	Occurring				Desirable			
	Generally true	Don't know	Generally not true		Generally desirable	No opinion	Generally undesirable	
(7)	1	2	3	White collar workers are outnumbering blue collar workers.				
	1	2	3	Except for scientists, professionals, and executives, the number of leisure hours (among waking hours) is becoming greater than the number of working hours for the bulk of the employed population.	1	2	3	(22)
	1	2	3	Career changes are becoming common--one's initial occupation is less likely to last out a working life than was true in the past.				
	1	2	3	A great many industrial jobs depending on unskilled and semi-skilled labor are being eliminated by automation and computers.				
	1	2	3	Scientists and professionals are having an increasingly important influence on economic and governmental policies.	1	2	3	(23)
(12)	1	2	3	Technologies for producing and distributing information (computers, mass media, etc.) are becoming as significant to the economy as technologies for producing and distributing energy (fuels, electricity, atomic energy etc.)				
	1	2	3	There is an increasing movement toward inter-city government embracing both urban and surburban areas, and adjacent cities	1	2	3	(24)
	1	2	3	Some business and industrial organizations are moving away from competitive relations toward more collaborative relations.	1	2	3	
	1	2	3	There is an emerging trend for major industries to regard their resources as belonging not just to them but to all of society.	1	2	3	
	1	2	3	There is a growing trend to coordinate major public and private services--for example, in housing, transportation, etc.	1	2	3	
(17)	1	2	3	There is a tendency for large neighborhoods to become more exclusive in the kinds of people who live in them--white middle class suburbs as well as parts of the "inner city".	1	2	3	(28)
	1	2	3	The market sector of the economy (manufacturing and private industry) is becoming less important than the non-market sector (services, non-profit organizations, households, etc.) in producing the wealth of our society.				
	1	2	3	Within the market sector of the economy, the activities of the larger enterprises are becoming increasingly international in scope.	1	2	3	(29)
	1	2	3	Increasingly, government is controlling the markets for the most advanced industries.	1	2	3	(30)
(21)	1	2	3	The cost of producing a major commodity such as new housing creates equally large costs for such consequent needs as expanded sewage systems, access road, traffic controls, recreational facilities, schools, public utilities, etc.				

THE COLLEGE ENVIRONMENT

4. Facilities, procedures, policies, requirements, attitudes, etc., differ from one campus to another. What is characteristic at the University? As you read each statement below consider 1) Whether it is true of U.C. generally, 2) Whether it is true of the College of Engineering, and 3) Whether you feel it is generally desirable or not. In the left hand columns circle the number under TRUE (T) if the statement describes a condition you think generally characteristic of the University at large, or FALSE (F) if you do not think it is characteristic.

   Then look at the statements again, and in the first two columns in the right circle numbers under TRUE if you think the statement is characteristic of the College of Engineering specifically, and FALSE if not.

   Finally, in the last two columns circle the number under DESIRABLE (D) if the statement describes a condition which you regard as a good characteristic, or NOT DESIRABLE (ND) if it is something you hope would not be characteristic of a college environment. Please answer every statement.

	Generally at U.C.			Generally in Engineering			Generally for me		
	T	F		T	F		D	ND	
(31)	1	2	Frequent tests are given in most courses.	1	2	(41)	1	2	(51)
	1	2	The college offers many really practical courses such as typing, report writing, etc.	1	2		1	2	
	1	2	The most important people at this school expect others to show proper respect for them.	1	2		1	2	
	1	2	There is a recognized group of student leaders on this campus.	1	2		1	2	
(35)	1	2	Many upperclassmen play an active role in helping new students adjust to campus life.	1	2	(45)	1	2	(55)
	1	2	The professors go out of their way to help you.	1	2		1	2	
	1	2	This school has a reputation for being friendly.	1	2		1	2	
	1	2	It's easy to get a group together for card games, singing, going to the movies, etc.	1	2		1	2	
	1	2	Students are encouraged to criticize administrative policies and teaching practices.	1	2		1	2	
(40)	1	2	The school offers many opportunities for students to understand and criticize important works in art, music, and drama.	1	2	(50)	1	2	(60)

Q. 4. continued

	Generally at U.C.			Generally in Engineering			Generally for me		
	T	F		T	F		D	ND	
(61)	1	2	Students are actively concerned about national and international affairs.	1	2	(1)	1	2	(11)
	1	2	Many famous people are brought to the campus for lectures, concerts, student discussions.	1	2		1	2	
	1	2	Students are conscientious about taking good care of school property.	1	2		1	2	
	1	2	Students are expected to report any violation of rules and regulations.	1	2		1	2	
	1	2	Students ask permission before deviating from common policies or practices.	1	2		1	2	
(66)	1	2	Student publications never lampoon dignified people or institutions.	1	2	(6)	1	2	(16)
	1	2	Most courses are a real intellectual challenge.	1	2		1	2	
	1	2	Students set high standards of achievement for themselves.	1	2		1	2	
	1	2	Most courses require intensive study and preparation out of class.	1	2		1	2	
(70)	1	2	Careful reasoning and clear logic are valued most highly in grading student papers, reports, or discussions.	1	2	(10)	1	2	(20)

(71-79)2

5. Several courses follow in which large numbers of students tend to enroll. Under each course are listed a variety of topics, information, and tasks to be accomplished.

Assume that you are enrolled in these courses and therefore must learn about each of the items listed below.

The items are listed in groups of three. For each group mark a . . .

"1" by the item that you would like most;
"2" by the item in which you would have an intermediate interest; and a
"3" by the item that would interest you least.

Examples:

Business and Economics

A

1. 2 The functions of the Securities and Exchange Commission.
2. 3 Factors operating to diminish the size of the U.S. gold reserve.
3. 1 When an "easy money" policy may be unsound public policy.

B

4. 2 The names of the components of the Gross National Product.
5. 1 The meaning of an "odd lot" in stock purchases.
6. 3 The purpose underlying agricultural price supports.

In Group A the respondent indicates that he is most interested in item 3 ("When an 'easy money' policy may be unsound public policy"); least interested in item 2 ("Factors operating to diminish the size of the U.S. gold reserve"); and has an intermediate interest in item 1 (The functions of the Securities and Exchange Commission."). Of the three items in Group B he is most interested in 5, least interested in 6, and has an intermediate interest in 4.

Do not assign the same rank to two items in a single group.

Geography

(21) A

___The factors responsible for westward population migration in the U.S.
___The names of the capitals of the European countries.
___The names and locations of the 10 largest rivers in the world.

Q. 5. continued
(1 = most, 2 = intermediate, 3 = least)

(22) B_____

___The average annual per capita consumption of petroleum products in the U.S.
___The definitions of Loess, mesas, drumlins, lithosphere, playas, and biosphere.
___Requisities for artesian well systems.

(23) C_____

___How artesian wells are formed.
___Forecasts about the weather to be expected in New York City during the next 48 hours from examination of a weather map.
___The chemical composition of lava.

(24) D_____

___The meaning of "cold", "warm," "occluded," and "cyclonic" fronts.
___The five major world producers (in order of importance) or iron, lead, zinc, and copper.
___The role of seaports in national economy.

(25) E_____

___The factors considered by geologists in attempting to locate oil deposits.
___Statistics on the average family size for each socioeconomic subgroup.
___Population shifts in the United States during the past 50 years.

(26)

Natural Science

(27) A_____

___The explanation for the fact that it is sometimes difficult to recognize voices on the telephone.
___The distances from earth to the other planets in our galaxy.
___The critical velocity required to escape the earth's gravitational pull.

(28) B_____

___The names of the elements included within the "halide" group.
___Statement of Newton's third law of motion.
___The significance of pH of 6.

Q. 5. continued
(1 = most, 2 = intermediate, 3 = least)

(29) C____

___Formula for converting centigrade temperature readings to fahrenheit readings.
___The difference in chemical structure between H_2O (water) and H_2O_2 (hydrogen peroxide).
___The distinction between "anode" and "cathode."

(30) D____

___Chemical factors associated with transmitting neural impulses.
___Why thrust is generated by a jet engine.
___The chemical structure on penicillin.

(31) E____

___The relative conductivity of certain substances (e.g., iron, copper, zinc, wood).
___The meaning of "specific gravity."
___The effect of increased pressure upon the boiling point of a liquid.

(32)

English

(33) A____

___Write a report on the novel entitled 1984.
___The names of Shakespeare's comedies.
___The reason why Hedda Gabler (in Ibsen's Hedda Gabler) kills herself.

(34) B____

___The names of 10 contemporary authors and their most important works.
___Write a biographical sketch based upon library research of any author (no longer living) of your choice.
___The effects of 19th centure Amer`ʼan history upon the American literature of the period.

(35) C____

___The elements in a play that lead to its classification as a "tragedy."
___The correct spelling for the word meaning "to pay" (i.e., is it "renumerate" or "remunerate").
___Write a theme about the most interesting person you have ever met.

Q. 5. continued
(1 = most, 2 = intermediate, 3 = least)

(36) D____

___The dates and major works of well-known poets like Whitman, Longfellow, Wordsworth, etc.
___The role of the playwright in contemporary society.
___The structure (i.e., number of lines, rhyming schemes, etc.) of sonnets.

(37) E____

___The influence of the Romantic poets on modern poetry.
___The times the different literary periods began.
___The essential difference between an epic and a ballad.

(38)

(39-40)

6. Please indicate the extent of understanding you feel you have about each of the following:

	A great deal of under-standing	Some under-standing	Little or no under standing	
The nature and requirements of my specific major in engineering	1	2	3	(41)
The subject matter of courses I have already completed toward my major	1	2	3	(42)
The nature of the various occupations my major is preparing me for	1	2	3	(43)
The nature of the requirements of the various majors within the school of engineering	1	2	3	(44)
The nature of the various occupations available to engineers generally	1	2	3	(45)

ERIC

7. Please indicate how you feel about each of the following statements. For each statement listed below, circle the number in the:

SA column, if you strongly agree, in the
A column, if you generally agree, in the
D column, if you generally disagree, or in the
SD column, if you strongly disagree.

	SA	A	D	SD	
An authoritative textbook is superior to reliance upon original readings.	1	2	3	4	(46)
It is a good learning experience for the student to be left with ambiguous or conflicting opinions so that he must arrive at the solution to a given problem on his own.	1	2	3	4	
Self-responsibility is best taught students by establishing definite rules of behavior (e.g., visitation privileges, study hours, and style of dress).	1	2	3	4	
I prefer to follow course work which emphasizes retention of facts.	1	2	3	4	
Students should participate significantly in the organization of courses and development of academic policy.	1	2	3	4	
Students should be given great freedom in choosing their courses of study.	1	2	3	4	(51)
I learn best when course presentation includes visual aids such as plates, models, and slides.	1	2	3	4	
Class assignments which depend upon the student's own initiative are preferable to definite, structural assignments.	1	2	3	4	
It is a good idea for faculty to mix informally with students by inviting them to their homes or by joining them in student lounges or snack bars.	1	2	3	4	
Students should be encouraged to seek their own answers to their questions.	1	2	3	4	
Lecture classes are superior to group discussion classes.	1	2	3	4	
Emphasis should be placed on independent study.	1	2	3	4	(57)

Q. 7. continued

	SA	A	D	SD	
I learn as well from hearing a lecture as from reading the same material in a book	1	2	3	4	(58)
A traditional college is preferable to one which emphasizes a lot of experimental courses.	1	2	3	4	
It is a good idea to indicate the relationship among courses instead of treating each course separately.	1	2	3	4	
Movies are very helpful in understanding course materials.	1	2	3	4	
I am quite concerned about how well I am doing in college compared with my classmates.	1	2	3	4	(62)
I often find myself bored in class	1	2	3	4	
In most courses I have had, students are treated more like apprentices than colleagues.	1	2	3	4	
I have found most of my instructors to be quite stimulating intellectually.	1	2	3	4	
Most faculty members in my department are really interested in their students.	1	2	3	4	
I have felt challenged to my full capacity by the requirements I have experienced at the University.	1	2	3	4	(67)
Most existing rules and regulations regarding student behavior are sensible and necessary.	1	2	3	4	
I am quite satisfied with my experience at the University.	1	2	3	4	
I have some doubts about whether engineering is really the right field for me.	1	2	3	4	(70)
					(71-79)3
I am not satisfied unless I have done my best in my course work.	1	2	3	4	(1)
I am generally very satisfied with my department at the University.	1	2	3	4	(2)

8. You are asked to rate each unit of Engineering 45 and the course as a whole in reference to the questions raised below. Please circle the one most appropriate number for each unit and for the total course.

How well did you understand the objectives of the course? (Scale: (1) Very well to (5) Not at all)

Internal Structure and Mechanical Properties section	1	2	3	4	5	(3)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

How well did the course sessions altogether seem to you to form a cohesive unit? (Scale: (1) Very well to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(7)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

How stimulating did you find the class sessions? (Scale: (1) Very stimulating to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(11)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastic section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

How informative did you find the class sessions? (Scale: (1) Very informative to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(15)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastic section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

To what extent were you encouraged to think independently? (Scale: (1) Greatly encouraged to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(19)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

Q. 8. continued

To what extent did the assigned readings and outside work effectively complement the basic course material? (Scale: (1) Greatly to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(23)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

How interesting did you find the readings? (Scale: (1) Very interesting to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(27)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

To what extent were you able to get personal help in the course, when you needed it? (Scale: (1) Greatly to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(31)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

To what extent did you understand what was expected of you and how your work would be graded? (Scale: (1) Greatly to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(35)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

To what extent do you feel your work has been graded fairly and carefully? (Scale: (1) Greatly to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(39)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

How well did the exams cover the important aspects of course material? (Scale: (1) Very well to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(43)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

Q. 8. continued

How much did the course enrich your personal learning experience? (Scale: (1) Very much to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(47)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

To what extent did you prepare for your classes? (Scale: (1) Very much to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(51)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

How well, on the average, would you rate your own attention and involvement in class? (Scale: (1) Excellent to (5) Very poor)

Int. Structure and Mech. Properties section	1	2	3	4	5	(55)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

How much, on the average, have your classes in this course pointed out gaps and inadequacies in your comprehension of material? (Scale: (1) Very often to (5) Seldom)

Int. Structure and Mech. Properties section	1	2	3	4	5	(59)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

To what extent did the course encourage critical thinking in the solution of problems? (Scale: (1) Greatly to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(63)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

To what extent has the course increased your theoretical understanding? (Scale: (1) Greatly to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(67)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	(70)

(71-79)4

ERIC

Q. 8. continued

To what extent has the course been helpful from a practical standpoint? (Scale: (1) Very helpful to (5) Not at all)

Int. Structure and Mech. Properties section	1	2	3	4	5	(1)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

How would you grade your professors as teachers? (Scale: (1) A to (5) F)

Int. Structure and Mech. Properties section	1	2	3	4	5	(5)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

Rate emphasis on exams: (Scale: (1) Emphasizes critical judgments and perspective to (5) Emphasizes recall of specific course material)

Int. Structure and Mech. Properties section	1	2	3	4	5	(9)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

In relation to other courses, rate the work load in this course. (Scale: (1) Light to (5) Excessive)

Int. Structure and Mech. Properties section	1	2	3	4	5	(13)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

Rate the value you place on this course in relation to other courses you have taken in the College of Engineering. (Scale: (1) exceptionally great value to (5) of very little value)

Int. Structure and Mech. Properties section	1	2	3	4	5	(17)
Electrical section	1	2	3	4	5	
Cement and Concrete, Wood, Plastics section	1	2	3	4	5	
The course as a whole	1	2	3	4	5	

Elaborate on any of the previous questions.
(21-22)

What do you feel are the strengths and weaknesses of individual units or of the course in general?
(23-24)

How do you feel the course could improve?
(25-26)

(71-79)5

Thank you for your cooperation!

INTELLECTUAL DISPOSITION CATEGORY CALCULATION*

CATEGORY

1	Average above 61 TI and TO above 54 TI or TO above 64 AU above 54	If any of these criteria not met, then category 2
2	Average above 53 TI or TO above 54 AU above 44	If not, then category 3
3	Average above 41 TI and TO below 55 AU below 55	If not, category 2
4	Average below 41 TI and TO below 55	If not, category 3

*Adapted from Cairne (1966) and Heist and Yonge (1968).

Description of CUES Scale

The 1963 version of CUES is a 150-item inventory; students respond with "true" or "false" to each item, depending on whether they feel the item is typical of their school. The inventory is scored to yield 5 primary scales with each scale composed of 30 items. The scales are described by Pace (1963, pp. 24-25) in the CUES manual as follows:

> *Scholarship:* "The items in this scale describe an academic scholarly environment. The emphasis is on competitively high academic achievement and a serious interest in scholarship. The pursuit of knowledge and theories, scientific or philosophical, is carried on rigorously and vigorously. Intellectual speculation, an interest in ideas as ideas, knowledge for its own sake, and intellectual discipline—all these are characteristic of the environment." Sample items are: "Students set high standards of achievement for themselves"; and "Most of the professors are very thorough teachers and really probe into the fundamentals of their subject."

> *Awareness:* "The items in this scale seem to reflect a concern and emphasis upon three sorts of meaning—personal, poetic and political....What seems to be evident in this sort of environment is a stress on awareness, an awareness of self, of society, and of esthetic stimuli. Perhaps...these features of a college atmosphere can be seen as a push toward expansion and enrichment." Sample items measuring Awareness are: "Students are actively concerned about national and international affairs"; and "The school offers many opportunities for students to understand and criticize important works in art, music, and drama."

> *Practicality:* "This combination of items suggests a practical, instrumental emphasis in the college environment. Procedures, personal status, and practical benefits are important....Order and supervision are characteristic of the administration and of the classwork. Good fun, school spirit, and student leadership in campus social activities are evident. The college atmosphere described by this scale appears to have an interesting mixture of entrepreneurial and bureaucratic features." Sample items are: "Education here tends to make students more practical and realistic"; and "Student organizations are closely supervised to guard against mistakes."

> *Community:* "The combination of items in this scale describes a friendly, cohesive, group-oriented campus. The environment is supportive and sympathetic. There is a feeling of group

welfare and group loyalty which encompasses the college as a whole. The campus is a community. It has a congenial atomosphere....If the organizational counterpart of 'practicality' was the bureaucracy, perhaps the counterpart of 'community' is the family." Sample items are: "This school has a reputation for being friendly"; and "Students' mid-term and final grades are reported to parents."

Propriety: "The items in this scale suggest an environment that is polite and considerate. Caution and thoughtfulness are evident. Group standards of decorum are important. On the negative side, one can describe propriety as the absence of demonstrative, assertive, rebellious, risk-taking, inconsiderate, convention-flouting behavior. Conventionality, in the sense of generally accepting and abiding by group standards, is in some respects a good term for the items in this scale....In any event, the atmosphere on some campuses is more mannerly, considerate, and proper than it is on others." Examples are: "Most students show a good deal of caution and self-control in their behavior"; and "Student publications never lampoon dignified people or institutions."

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